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THE LAST WORD IN STEEL
THE ROMANCE OF INVENTION

SCIENTIFIC AMERICAN

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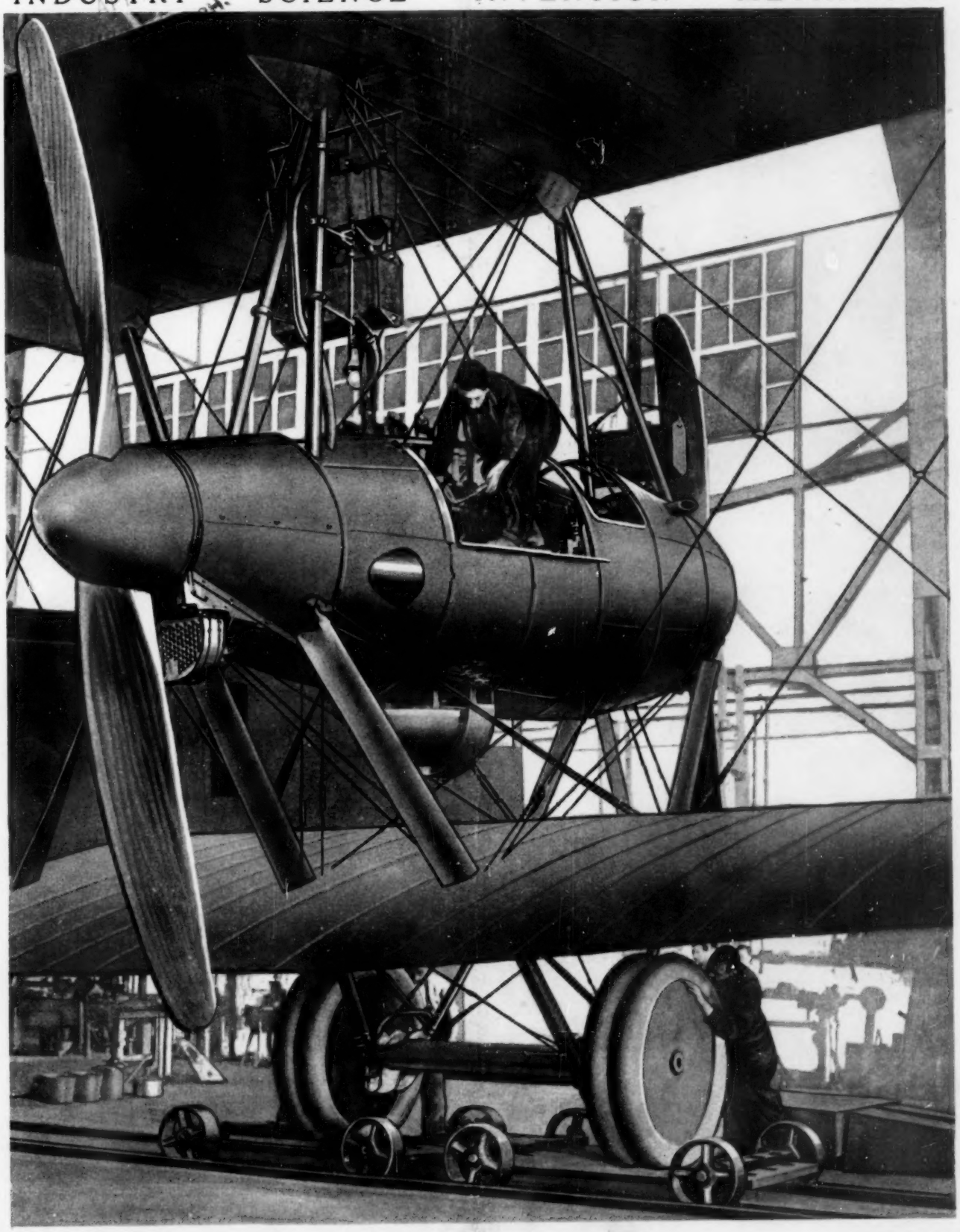
A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



TUNING UP A GIANT AIRPLANE FOR FLIGHT

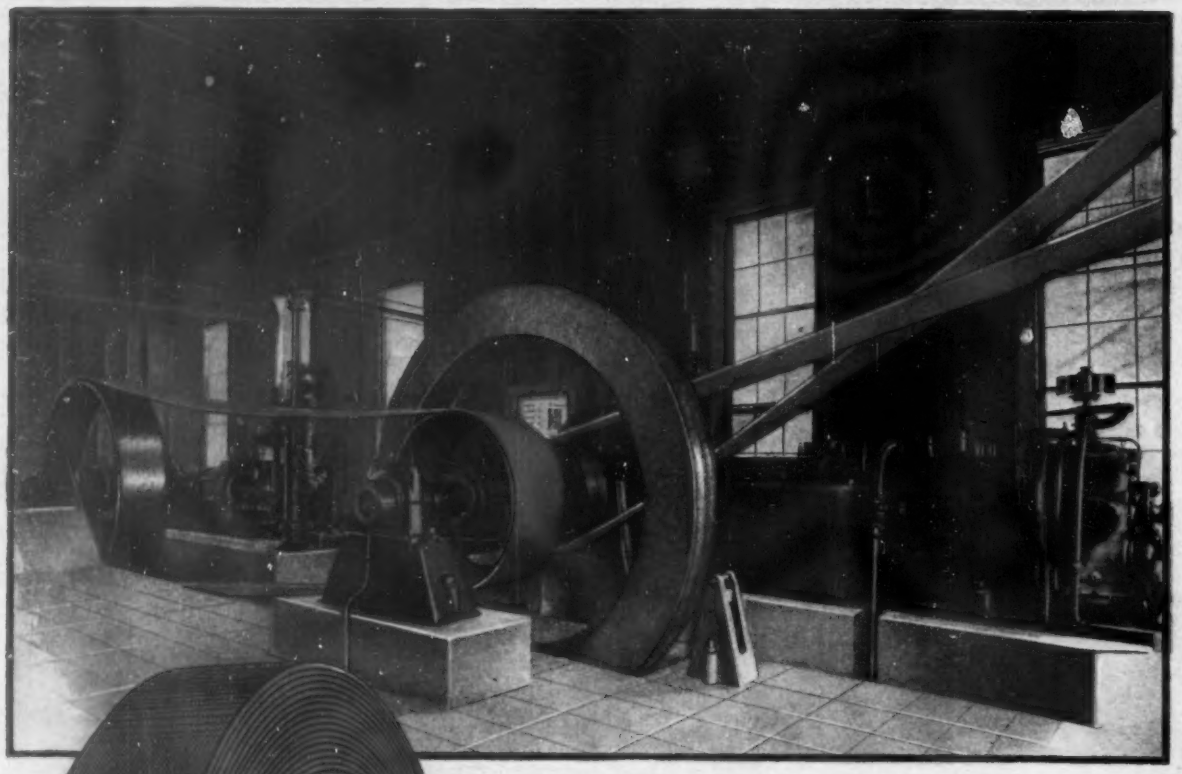
Vol. CXXII. No. 13
March 27, 1920

Published Weekly by
Scientific American Publishing Co.
Munn & Co., New York, N. Y.

Price 10 Cents
$5.00 a year

Entered as second class matter June 18, 1879, at the post office at New York, N. Y., under the Act of March 3, 1879

RAINBOW
FRICTION SURFACE BELTING



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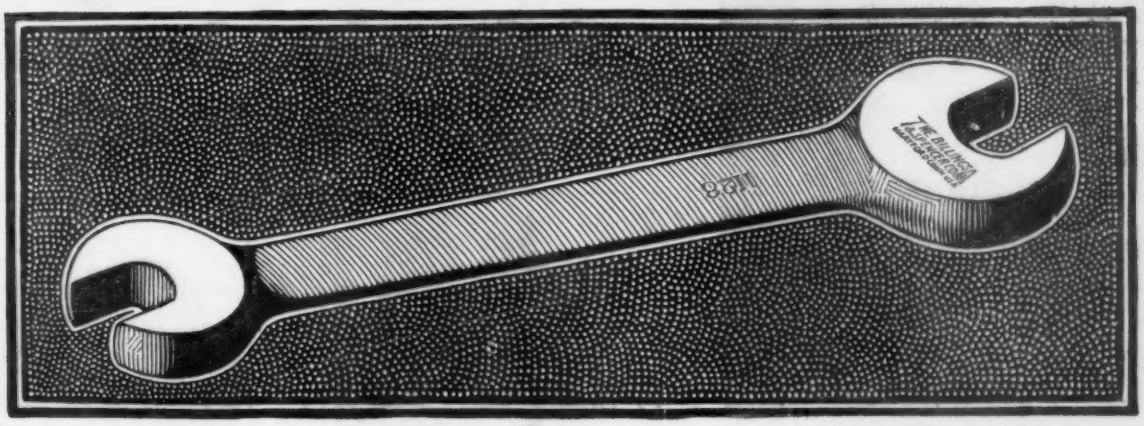

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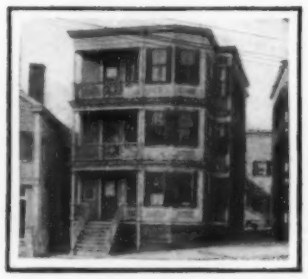
RELY B ON ME

Salem has burned its last witch



Frame dwellings, old Salem—Inflammable Roof

Fire-safe dwelling, New Salem—Johns-Manville Asbestos Roofed

NOT a hundred years ago, but in only the last decade, did Salem burn its last witch, for the witch we mean is the dangerous, inflammable roof, really more of a menace to the welfare of any community than all the broom-stick riding hags of fable or tradition.

The old witch was an imaginary menace. The roof that can take fire from the slightest spark is a real, ever present danger.

In the big fire of 1914 Salem burned up these witches, her last witches. Great as was that disaster it at least brought one benefit, it consumed the hazard by which it had been bred.

A new Salem has grown up out of the blackened stumps of her fire, a safer community, with new dwellings, industrial and business buildings of modern, fire-safe construction, including many fire-safe roofs of Johns-Manville Asbestos.

And other communities the country over have read the lesson of the Salem fire, other cities have banished their witches before burning them and substituted fire-safe roofs of Johns-Manville Asbestos.

A building covered by a Johns-Manville Asbestos roof is safe from communicated fire. It is fortified where ordinarily it is most undefended and most vulnerable—and not alone from fire but from weather and time as well.

Asbestos is a mineral born out of earth pressure and great heat, and tested for eons by the elements. Not hard to understand, then, that Asbestos when incorporated into the roofings listed below, becomes a barrier against weather, time and fire.

Asbestos Roll Roofing, Johns-Manville Standard and Colorblende Asbestos Shingles, Johns-Manville Asbestos Ready Roofing, Johns-Manville Corrugated Asbestos Roofing, Johns-Manville Built-Up Asbestos Roofings. Johns-Manville Asbestos Roofings are approved by the Underwriters' Laboratories, Inc.

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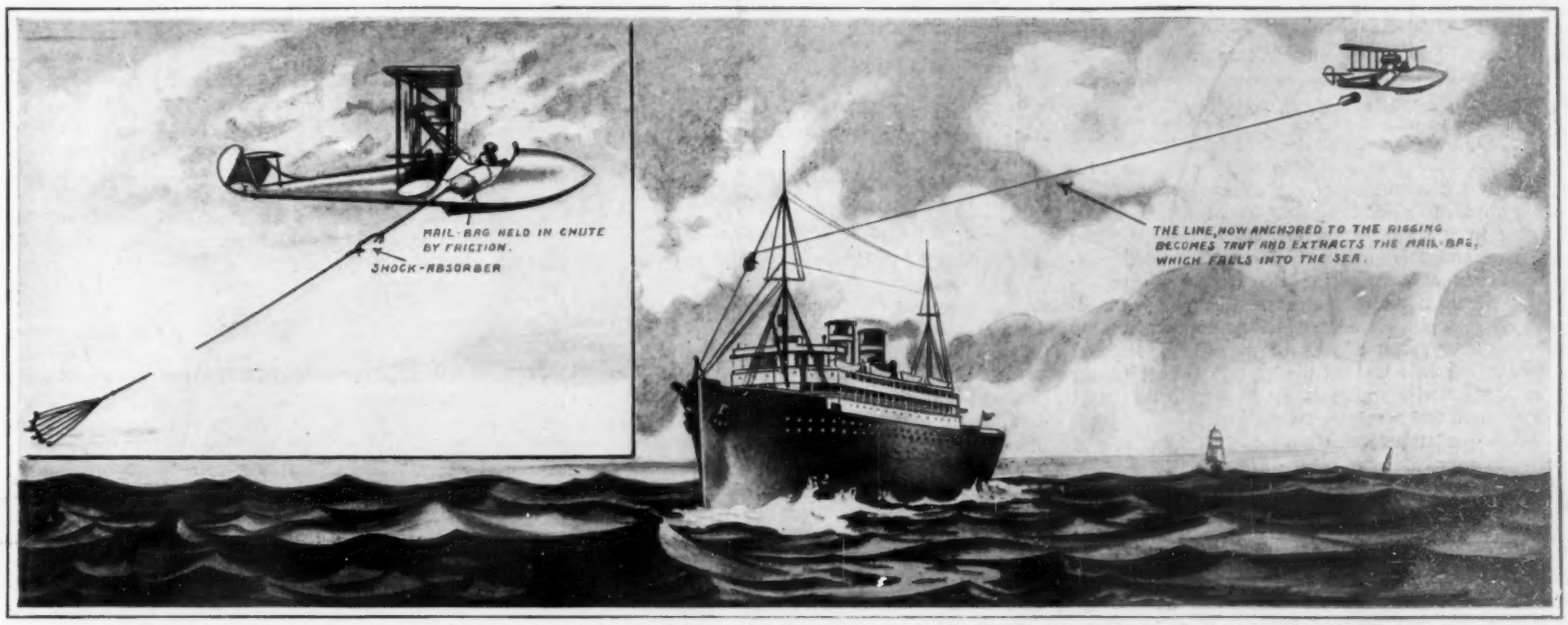
SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CXXII. NUMBER 13 | NEW YORK, MARCH 27, 1920 | 10 CENTS A COPY $5.00 A YEAR


MAIL-BAG HELD IN CHUTE BY FRICTION.
SHOCK-ABSORBER
THE LINE, NOW ANCHORED TO THE RIGGING BECOMES TRUT AND EXTRACTS THE MAIL-BAG, WHICH FALLS INTO THE SEA.

How the aerial postman can overtake steamers at sea and deliver belated mail by means of a simple grapple, line and water-proof mail container

Mail Delivery to Ships at Sea

BECAUSE of the great speed of the airplane and the relative slow speed of the steamer, it has long been evident that much time might be gained in the mailing of trans-oceanic correspondence if airplanes were employed at least at the point of departure. That is to say, a steamer could be overhauled by a fast airplane, carrying belated mail, some hundreds of miles out at sea, or, to put it in other terms, when almost a day out, depending on the conditions. There are certain routes taken by steamers that bring them well within reach of other parts of the coast, so that an airplane does not necessarily have to make the entire trip from the steamer's point of departure. The airplane base can be somewhere along the coast so as to make the trip to the steamer that much less, and all mail matter intended for steamers can be forwarded to the remote base.

Experiments have been carried out with airplanes as mail carriers to ships at sea, and with much promise of success. In fact, the present halt is due mainly to the lack of initiative on the part of the governments and companies concerned, rather than to the lack of material means.

A recent method of delivering mail by airplane to steamers at sea is depicted in the accompanying drawings. The water-proof mail container, it will be noted, is carried by the flying-boat in a chute built on the side of the hull and slanting downwards. The bag is held in place by friction. Attached to it is a trailing line with a seven-tailed grapple at the end for catching the rigging of the ship. When it catches, the line is pulled taut and the mail bag is jerked out of the chute to fall into the sea. The line is provided with suitable shock-absorbers so that it will not break. The bag, after falling into the sea, is hauled aboard while the liner continues on its way.

A previous method of delivering mail to ships made use of a bag, a line and a float. The airmen dropped the float on one side and the bag on the other of the steamer, so as to straddle the bow. However, such a method requires a considerable degree of skill, and the attempt can only be made once. The present method, on the other hand, is relatively easy, since the pilot passes over the steamer with the line trailing down, and the bag is automatically dropped only after the line has been anchored to the rigging.

Detecting Men By Their Heat Radiation

IF the war had not ended in November, 1918, and we had settled down to another winter of it, the normal course of trench warfare might have been profoundly modified by an instrument which was introduced in August, 1918, and was described at a meeting of the American Physical Society in Washington recently. It consists of a Hilger thermopile mounted in the focus of a 14-inch parabolic mirror, silvered on the surface, together with a d'Arsonval galvanometer. The heat radiations from any object focused by the mirror act on the thermopile and cause deflection of the galvanometer.

Early in 1913 experimental work was started on the problem of detecting men and other objects, at a higher temperature than their background, by their thermal radiation. The results proved that men could be detected with ease at a distance of 600 feet, while a man lying in a depression in the ground at 400 feet could be detected as soon as he showed the upper part of his face above the ground. At moderate ranges no man could cross the range of the instrument without giving a marked indication, whether he was crawling or running. The night patrols and working parties in "No Man's Land" would have had a bad time if their service had been required in the winter of 1918, for their presence would instantly have been detected by means of the instrument. Surprise attacks under cover of fog, such as the attack on the British Army in March 1918, might also have been prevented, though it is possible that the absorption of heat by the mist would prevent the radiations reaching the mirror. Experiments were carried out in the detection of aircraft at night, but these were not sufficiently advanced to show whether the method was of value for that purpose or not. An instrument of this kind should have a useful application in work other than that of war. If the regular police can find no use for it, the scientific detective, who is so prominent in modern fiction, could certainly employ it in detecting crime. In industry, too, it should find a place, for its work is not confined to detecting the presence of human beings. It is so sensitive that it can detect the difference between the painted and the unpainted side of a steel plate, of which the temperature is slightly higher than that of the surrounding atmosphere; it would be of great value in determining the relative efficiency of coverings on steam pipes to prevent radiation.

Artificial Air in Coal Mines?

THE question of charging coal mines with atmospheres poor in oxygen, in order to reduce the dangers of explosions, came up before the Society of Chemical Industry in May last, in connection with a "Note on Explosions in Coal Mines," communicated by Dr. G. Harger. The suggestion of diluting the air in coal mines with a sufficient amount of flue gas was made by Dr. J. Harger some years before the war. Attention had recently been drawn to the matter again by T. J. E. Rhead in his experiments on residual and extinctive atmospheres. Rhead had found that an atmosphere containing 17 per cent of oxygen would still be able to propagate an explosion, contrary to Harger's opinion. Harger pointed out that the flue gas would, of course, have to be purified of all carbon monoxide before it would be mixed with an air to be breathed, and that would be very difficult; 0.3 per cent and less of carbon monoxide is sufficient to kill rats in enclosed spaces. Moreover, men cannot work in so poor an atmosphere, though Haldane showed that man can exist for a time in an air containing as little as 12 per cent of oxygen. It is true that at altitudes of 6,000 feet the partial pressure of oxygen is reduced to a value corresponding to the 17 per cent mentioned, but such air does not contain 4 per cent of carbon dioxide occurring in flue gas.

SCIENTIFIC AMERICAN

Published by Scientific American Publishing Co.
Founded 1845
New York, Saturday, March 27, 1920
Munn & Co., 233 Broadway, New York

Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary; all at 233 Broadway

Entered at the Post Office of New York, N. Y., as Second Class Matter
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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The University in Industry

THE great demand of the industries today is for men trained to solve the many problems with which the industries are confronted. This requires a knowledge of the principles of science, and a training in the application of this knowledge. The first requirement is sufficiently met by the undergraduate courses of instruction; the second can be obtained only to a limited extent in the four years allotted to undergraduate work. The student must be encouraged to spend a year or more in a research laboratory, or in advanced study. He is best taught to solve industrial problems by having him attempt their solution under able guidance.

But industrial problems have their origin in, and owe their very existence to, the industries themselves. An educational institution which sets out to train men in their solution will have to make some sort of an appeal to the industries—in some form it must ask: "Lend us your problems to work on." The success of this appeal depends upon the form in which it is made. Purely philanthropic enterprises do not engender in the managers of industry that confidence which is necessary to success. There must exist in the scheme of coöperation between the educational and the commercial establishments an element of mutual obligation and mutual benefit.

Massachusetts Institute of Technology has recently put into practice a plan for meeting these requirements which already has been copied at one or two other institutions. The "Tech" plan consists of a formal contract between the Institute and the industrial organization. The company agrees to pay the Institute a fixed annual retainer during the life of the contract—which is usually for five years. The Institute in return agrees to make available to the company during this period its library, its files, and the services of its staff for consultation; to maintain as complete a record as possible of the special qualifications of its alumni, to maintain a list of undergraduates who wish positions upon graduation, and to assist the company in making proper selection from these; to advise the company where any special technical problems requiring extended consultation, investigation, research or tests can best be handled, and if by its own staff or laboratories, to provide for this service at a proper fee.

The mutual benefits of this program are obvious. The Institute agrees in its contract to maintain a steady stream of trained men constantly flowing into industry with the best preparation for scientific work which it is possible for it to give them. At the same time, the results of research work thus obtained will swell the store of knowledge on which depends the scientific progress of the country as a whole. As a corollary to this duty of preparing educated men is the duty of seeing that, as far as possible, these men take positions for which their natural ability and aptitude most nearly fit them. Further, it is desirable that as these men develop into specialists in any field, their sphere of influence be made as wide as practicable. While the service of making contact in thoroughgoing fashion between the man and the job has been rendered in some degree in the past, it has been a minor part of the Institute's work, and incidental to other activities. It will now become a contractual obligation.

The instructing staff of an educational institution is made up, at least theoretically of men peculiarly adapted to render great public service by conducting research of a fundamental character. They are seekers after new knowledge, and yet they are at the same time teachers and trainers of young men. It is important that these men be not withdrawn into purely industrial work by reason of the greater financial return offered by great corporations, or the acute pleasure which many red-blooded men feel in being professionally connected with great technical developments. Hence the "Tech" plan provides a method by which the demands of the industries for trained research men of outstanding ability can be met, and the demands of these men for remunerative connection with industry can at the same time be satisfied, without sacrificing the connection of such men with the Institute. The Institute staff is able to profit by contact with men of affairs and to receive the inspiration that comes from capitalization of effort.

Massachusetts Institute of Technology has already entered into 190 contracts under this plan. The Institute earnestly hopes that its plan will be adopted, with improvements, by other educational bodies, to the benefit of both education and industry.

Our European Account

TODAY'S definition of healthy conditions in trade between the United States and Europe is in many ways different from one which might have been accepted five years ago. Before the war, European investment in our railroads, industries, municipal bonds and other securities was very large, and on the whole was increasing rather than the reverse. We had the interest on this debt to pay, and, at maturity, the debt itself. Moreover, we were still fundamentally an agricultural nation, exporting food and raw materials in exchange for manufactured goods which we did not produce in sufficient quantity or sufficient variety to supply all our own needs. The first condition made it imperative that we export more to Europe than we import, in order to create a favorable balance of trade; the second condition made it possible for us to maintain that favorable balance. If we supply raw materials for the factories of Europe and buy back only such of the finished product as we ourselves can consume, the extent to which Europe's products are bought by others than ourselves, plus the extent to which we supply actual foodstuffs for Europe's consumption, is far more than adequate to pay the manufacturing profit on the finished articles which we buy.

Today, however, with regard to Europe's chief markets, our situation is precisely reversed. Our productive capacity has increased until we are able not only to supply a great list of manufactured articles for our own wants but actually to produce a surplus for sale abroad. At the same time European holdings of our securities have been largely liquidated, while we have loaned vast sums, through Government and private channels. So the inevitable conclusion is that European sales to our people must increase, both to provide the means for Europe to pay us our interest and eventually our principal, and to afford a means of exchange whereby our own sales in European markets can be paid for.

In the face of this situation, Europe's need for our goods is pressing. Europe will not be able to produce goods for sale here until her production has recovered to the point where a surplus can be produced. We cannot be paid what is owing us and what further sums we may advance until industry in Europe is again humming. Yet industry in Europe cannot hum until raw materials and machinery are available. It looks like one of those endless chains in which there can be no break; but in reality it is not quite so bad as that.

When a bank lends money to one of its clients, and in doing business on that money the client uses up the loan and is still not at the point where the returns from the business are sufficient to carry it, there are just two things for the bank to do. It can close down on him, forcing him to sacrifice his business for less than its true value and, ordinarily, for less than the amount of the loan. Or it can protect the funds which it has already advanced by advancing more. The decision between these alternatives rests upon the bank's opinion of the debtor. If he is competent and honest, it will ordinarily assume that he can pay and will pay if given a chance; if it appears that his failure to get his business under way is the result of incompetency or dishonesty, it will close down on him, sell him out for what he will bring, and write off the balance as loss.

The United States today is the banker, Europe is the borrower who stands before us asking for further credit in order that she may pay us what she already owes us. If we believe that Europe is going to the "demnition bow-wows" and will never be able to pay her debts, it will be the sensible course to pull out of the mess and recover what we can from the crash. If, however, we believe that France and Italy and Britain and Belgium—and Germany—can pay and will pay from the proceeds of future business, it is up to us to make future business possible for them by extending liberal credits. There is no middle course.

Specifications

SPECIFICATIONS, of course, are an engineering necessity. If we attempt to manufacture anything in the world without a complete set of specifications, we shall be hopelessly lost before ever we get started. But a prominent manufacturer suggests that to specifications as to all other things in the world we may justly apply the adage telling us that there is a place for everything, and implying that we should keep each thing in its place.

Suppose you go into a jeweler's store for a watch. Suppose the proprietor, anxious to make a sale, shows you a time-piece, and begins to urge its merits upon you by telling you its weight, its diameter, its thickness, the length of its mainspring, the number of teeth in its several wheels and the consequent gear reduction between the driving wheel and the hands; suppose he recites to you the chemical analysis of the glass in the crystal and the steel in the mainspring and the ink with which the hours are marked on the dial; suppose he flashes a bulky roll of blueprints upon you to convince you that the construction of the watch is all it should be.

An engineer—that is, an engineer who has had experience with watches—would doubtless be able to settle for himself, after such an exhibit, whether the watch would keep good time. But one does not carry a watch-engineer about with one in the search for a timepiece. What the prospective purchaser of a watch wants to know is whether it will answer his requirements for a timepiece and at the same time please him with its appearance, at a price which is what he can afford to pay. The manufacturing specifications have not the slightest bearing upon this, save in the mind of a man so skilled in watch-making that he would require no guidance whatever in his purchasing.

Now, when you are in the market for an automobile, or a motor truck, or a tractor, the average salesman and the average selling organization inundate you with specifications much as does the imaginary jeweler of our fable. Does this maze of statistics really mean anything to you, beyond what the man behind them tells you it means? He reels off a mass of figures about gears and gear ratios and revolutions per minute and leaves you in a fog; then he tells you that this all means that the car can go up a twenty-degree incline on high, and the fog is somewhat dissipated. But why could he not have made the last statement first, and let it go at that?

We venture to assert that in nine cases out of ten the manufacturing specifications mean nothing to the user of a machine. Tell him what it will do, show him how to make it do it, and he knows what he wants to know about it. Good specifications are a prerequisite to a good machine, of course. But why thrust them on the buyer? The housewife who buys bread on the strength of a chemical analysis is almost a *non est*. The engineer who buys wire may properly ask for a statement of its composition and its tensile strength and its conductivity, but the individual user who wants the wire to wrap around a package or to hang down his well with a load on it or to attach to his door-bell depends upon his dealer to give him a wire that will serve for the purpose in question.

Electricity

Improved Telephone Service.—One of the principal causes of delay in effecting connections on the Paris telephones, according to a French writer, arises from the necessity of the operators in different exchanges having to talk with one another. It was intended to remedy this by the use of semi-automatic apparatus, but the war has retarded the installation of the plant, and it is suggested that, without giving up the plan, it is possible to effect an immediate improvement by using a new method of calling up. The subscriber wishing to call a number at a different exchange first asks his exchange for the desired exchange and, when connected, asks for the number that he requires. It is claimed that this process will effect a saving of time.

Sizes of Electric Cables.—The determination of the size of cables can be regarded from two standpoints: (1) that of voltage drop along the cable, and (2) the safe current-carrying capacity of the cable.

Kelvin's law of the most economical loss at which to work a cable is discussed, and it is pointed out that this law is based on the invalid supposition that the capital cost is proportional to the size of the conductor. An approximate expression is deduced for the safe current in an insulated conductor, making allowance for heat losses, and it is shown that the safe current-carrying capacity is proportional to three-quarters the power of the cross-sectional area. This shows that the old rule allowing 1,000 amperes per square inch is wrong on rational principles.

High Voltage Trolley Lines.—The increase in the length of the lines and the power developed by the locomotives on long-distance railways run on single-phase alternating current necessitates a substantial increase in voltage. The Dessau-Bitterfeld service in Germany was begun on 10,000 volts, which was subsequently raised to 15,000 volts. It seems that this voltage is not likely to be increased in the near future. The construction of the trolley-wires on long-distance service must not only be adapted to the increased voltage, but also to the increased speed of some 80 miles per hour. The usual method of suspension used on Continental railroads cannot therefore be used for such lines, and a multiple suspension of the trolley wires from a cable under tension must be substituted similar to that used on some American electrified railroads. A system has recently been developed in Germany which insures a perfectly horizontal position of the trolley-wire, even when the temperature changes, and thus permits a satisfactory means of contact even at high speeds.

Cadmium Electrode for Battery Testing.—In the operation and testing of storage cells, it is frequently important, particularly in cases of low capacity, to know the individual potentials of the positive and negative plates of the cell. No standard method of measuring the potentials of storage battery plates is recognized, but for many years the common method has consisted in measuring the potential differences between either plate and a piece of metallic cadmium with an ordinary voltmeter. This method often leads to contrary results and voltmeters vary greatly in resistance. The U. S. Bureau of Standards undertook this investigation to determine the accuracy of the cadmium electrode and the errors to which it is subject. As a standard electrode, the mercurous sulphate half-cell was adopted after experiments which showed it to be well adapted to the purpose. The reproductibility of the cadmium electrode was first determined and then the effect of temperature, the effect of drying the electrodes and the polarization of the electrode were studied. The constancy of the cadmium electrode during measurements of the potentials of storage battery plates when on charge and discharge was also determined. This investigation deals only with the accuracy of the cadmium electrode and does not discuss the cadmium readings with reference to the age or the condition of the battery. The most important error found was due to the polarization of the electrode, but this error can be easily avoided if the electrode is used to measure the potential of the negative plate from which the potential of the positive plate may be calculated if the cell voltage is known. This is contrary to the way the electrode is generally used, but it eliminates the chief error which arises when the ordinary voltmeter is employed to measure the voltage.

Science

The James Watt Centenary.—The hundredth anniversary of the death of James Watt, the chief contributor to the invention of the steam engine, was commemorated by special ceremonies at Birmingham, England, September 16-18. The university held a degree congregation for conferring honorary degrees on distinguished engineers and men of science, and visitors were given an opportunity of seeing two of Watt's engines at work. Funds are being raised to endow at the University of Birmingham a James Watt chair of engineering for the promotion of research in the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy; also to erect a memorial building, which will house a Watt museum, besides serving other purposes in connection with engineering. A memorial volume is also to be published.

A Drug Garden has recently been established at the University of Michigan with the aid of funds supplied by a well-known firm of manufacturing pharmacists in Detroit. This is one of several recent steps taken in this country toward securing a greater degree of standardization in medicinal plants. "In this day of enlightenment," as we read in a report on the Michigan undertaking, "the time is about gone when a thousand pounds of any commercial drug should represent the collections made by many unskilled collectors, situated at widely different points and collecting at different months throughout the year." The new garden will serve as a center for various lines of research, including morphologic and taxonomic studies of drug plants, breeding for yield of drugs and increase of active principles, critical studies of assay methods, studies on the chemistry of vegetable drugs, their pharmacologic action, etc.

The International Electro-Technical Commission, met in London October 20-23, under the presidency of M. Maurice Leblanc. The meeting was attended by delegates from twenty countries. From an account of the proceedings in *Nature* we learn that progress has been made toward securing international uniformity in the use of symbols. National agreement on this subject has already been attained in Italy, as to symbols used in text-books and engineering drawings. The British list of symbols, which is finished and will soon be published, is very similar to the Italian list. Several committees on nomenclature have published lists of definitions, etc., on the basis of which the Commission hopes to publish a standard list for international use. The Commission has undertaken to prepare a specification for aluminum on the same lines as that adopted for pure copper, which has now been accepted in every country in the world. A feature of the meting was a banquet, at which the Right Honorable A. J. Balfour made an interesting speech on the advantages of standardization.

Hay Fever Studies.—Dr. William Sheppegrell, chief of the hay fever clinic at the Charity Hospital, New Orleans, and president of the American Hay Fever Prevention Association, has published numerous important papers on this annoying disease. From the latest of these, appearing in *Public Health Reports*, several facts of novel interest may be gleaned. He states that as a result of a weed-cutting campaign carried out in New Orleans in the spring of 1916 the number of hay fever cases was reduced to less than 50 per cent of the usual prevalence. The "cold storage" treatment of the disease, in which practically all ventilation is excluded in order to ensure the absence of atmospheric pollen, is said to afford only transient relief, while the low temperature is likely to cause bronchitis. The effects of an abundant rain on hay fever patients is beneficial, because the rain not only washes the pollen out of the air but also permanently removes its toxic qualities, so that it is harmless when again blown into the air after the rain is over. This has been proved by laboratory experiments, in which pollen, after submersion in water, was inhaled by hay fever subjects without any apparent effect. As to hay fever "inhalers," which are supposed to filter the inhaled air free from hay fever pollens, Dr. Scheppegrell finds them of doubtful value and so uncomfortable to wear that patients prefer the disease to the inhaler.

Automobile

The German Army Truck is the subject of a careful analysis in a recent issue of *Automotive Industries*, the author being Mr. C. R. Hays, chief of the experimental section of the Motor Transport Corps. He makes a careful comparison with the American practice, finding rather less marked points of divergence that one might expect.

A New System of Night Signals consisting of colored lights to be used in connection with the head- and tail-light circuits, has been devised by a South African motorist. With his code it is possible for the man ahead to inform the man behind of his every intention, or to make it clear to the traffic officers whether he desires to go straight ahead, to the right or left, or to stand on his tail and spin around in a circle. Seriously, is it not about time that this invention of new universal sign-languages for the motorist was brought to a halt?

The Primary Current may be determined for the moment of break by an apparatus recently described by Dr. N. W. McLachlan before the Physical Society of London. Briefly the method consists in connecting a condenser across the secondary winding in such a way as to reduce the secondary voltage below that required for sparking at the safety gap. The peak voltage due to current interruption at any speed is found, and then the interrupted direct current that would give the same voltage is determined, this being equal to the current at break in the magneto.

The Price of Gasoline is beginning to get beneath the sensitive British skin, if we may judge from a rather sharp note in a recent issue of *Autocar*, which sets forth the editorial opinion that until effective prevention is put in force, "the petrol magnate will inflict the last judicious squeeze upon our pockets." Our British contemporary justifies the use of the hopeful term "judicious" in this connection by supposing that not "even the oil ring is so rapacious as to desire to kill its British market." If the editors pen this warning with the idea that they have up their sleeves an effective substitute for gasoline, we wish they would share it with the American sufferers from the 33-cent visitation.

Relation of Age to Repairs.—Data collected by the United States Bureau of Markets shows how the cost of repairs increases with the age of the truck. Those operators who have purchased second hand or used equipment have found their repair bills relatively higher. Repairs during the first year's service of the new truck are not a very serious consideration. When the truck is in continuous use throughout the year, it is usually laid up once each year and given a complete overhauling. The cost of this depends on the age of the machine, the care which it has received and its size. The figures compiled show that the annual cost of overhauling the motor truck ranges from about $100 to as high as $800 or $900. Truck owners who make it a point to keep their trucks in a constant state of repair have relatively small charges to meet for annual overhauling. Those who operate their machines as long as possible with no regular repairs must often face an extremely heavy charge for repairs at the end of the year.

Farmers Use Most Motor Trucks.—Some very interesting figures are given in a recent issue of the S. A. E. Bulletin, which show that the American farming class is the largest user of motor trucks in the world. In 1917, the last year for which complete statistics are available, there were 79,789 motor trucks in operation by farmers. Manufacturers ranked next with 75,928 trucks, while 74,486 vehicles operated by retail merchants took third place. While the estimates for 1918 show a marked increase in the number of motor trucks in use, the farmer still retains his leading place. It is estimated that in the last year approximately 350,000,000 tons of farm products were hauled to market in motor trucks by the farmers and market gardeners of this country. The cost of handling this large quantity of produce, much of which was of a perishable nature, was approximately half that of horse-drawn transportation, according to an average of the actual operating figures which have been compiled for the entire United States and which cover a wide range of local conditions.

The Panama Canal Today

The Construction and Operation of the Great Waterway Between the Atlantic and the Pacific

By J. Bernard Walker

THE opening of the Panama Canal in 1914 was the fulfilment of a dream which for many centuries had possessed the minds of navigators, ship owners, captains of industry, admirals of fleets and governments of the world. Commenced by the French and completed by the United States Government, this great waterway between the Atlantic and the Pacific, serving at once to sever two continents and unite two oceans, ranks, and will ever rank, as one of the greatest single engineering feats of all time. On May 4th, 1904, the Government of the United States entered into possession of a strip of land ten miles in width, extending across the Isthmus of Panama and from ocean to ocean, which is now known as the Canal Zone. On August 15th, 1914, a few days after the great war burst upon the startled world, the Panama Canal was opened to commerce.

Topographical Features

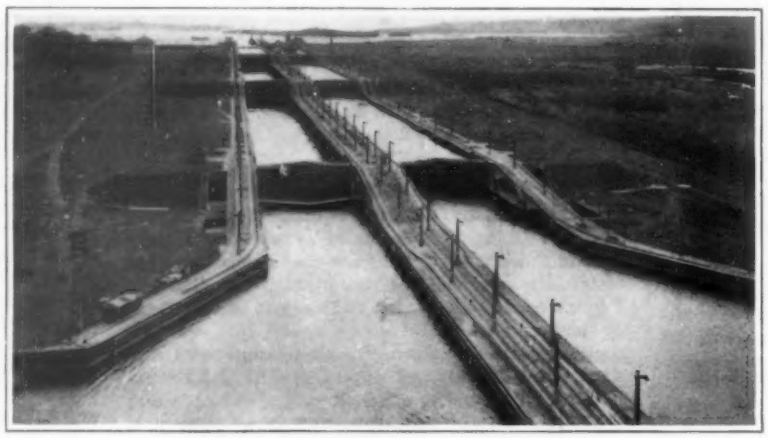
The Isthmus of Panama, a narrow neck of land, about thirty miles wide as the crow flies, connects the two continents through an elbow which is in the form of a segment of an arc, and runs approximately east and west, the Canal extending across the Isthmus in an approximate north and south line. In places the land is gently undulating, in others, more hilly and picturesque, and at the great Gaillard Cut, formerly known as Culebra Cut, it passes through the Continental Divide, which here rises some 700 feet above sea level. The route follows the valley of the Mindi and Chagres Rivers on the Atlantic slope of the Divide, beyond which it passes through the valley of the Rio Grande on the Pacific slope down to tidewater. Sea level channels were dredged inward from either end of the Canal as far as practical, that is, from deep water in the Atlantic southward to Gatun, and from deep water in the Pacific northward to Miraflores. The intervening distance from Gatun to Miraflores consists of two artificial lakes which were formed by damming the waters of the Chagres and the Rio Grande Rivers. The first of these, Gatun Lake, extends from Gatun to Pedro Miguel on the Pacific side of Gaillard Cut. Then follows Miraflores Lake, which extends from Pedro Miguel to Miraflores. The elevation of Gatun Lake is 85 feet above sea level, and of Miraflores Lake 54 2/3 feet above sea level.

A Trip Through the Canal

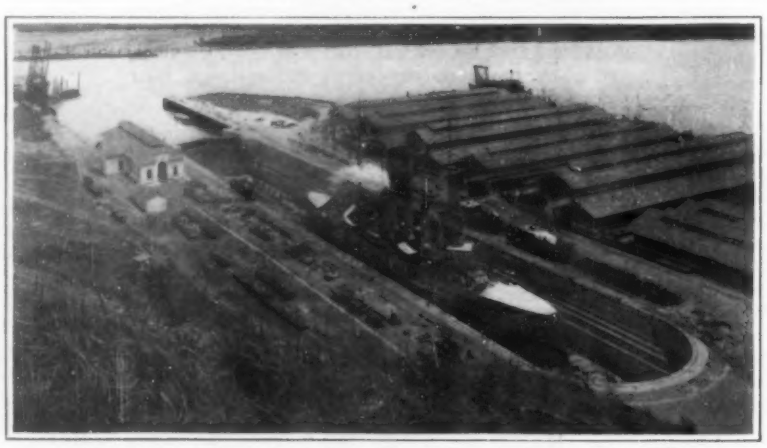
In making a trip through the Canal, let us say from the Atlantic to the Pacific, the first evidence of this vast work will be a view of the great rock breakwater, which has been built out from Toro Point into Limon Bay, or Colon Harbor, for a distance of over two miles. The purpose of this breakwater is to convert the bay into a safe anchorage, to protect shipping in the Harbor of Colon, and to shelter vessels which are making the Canal. To the left, extending from Cristobal, is a great artificial mole, from which six fine piers reach into the bay. Beyond the end of the lighthouse commences a channel with a depth of 45 feet and a width of 500 feet which extends in an almost straight line for 7½ miles to the Gatun locks. The locks are on the left side of the Chagres valley, and to the right of them the valley has been closed by a huge dam 1½ miles in length, nearly half a mile wide at the widest point of its base, and about 100 feet wide at the top. This dam cuts squarely across the bed of the old Chagres River and serves to impound its waters, forming a lake whose area is 164 square miles and whose normal elevation is 85 feet above sea level. During the rainy season, floods of great volume pour down the Chagres River into the lake, and the surplus waters are allowed to flow over a concrete spillway, the discharge channel of which is 285 feet wide and 1,200 feet long. The spillway dam is in the form of an arc of a circle, and measures 808 feet along its course. The top of the dam is 69 feet above sea level, and it is surmounted by regulating gates 20 feet high, the tops of which are two feet above the maximum elevation of the lake. The height of water in the lake is controlled by these gates, which slide between vertical concrete piers. They are raised and lowered by electric power from a power plant at the spillway, which serves also to provide power for the electric operation and lighting of the locks and the general plant throughout the full length of the Canal, which, it should be said, extends for a total distance, from deep water to deep water, of about 49 miles.

The Gatun dam consists of two massive rock fills, with a vast central core of mud and clay which was pumped in hydraulically and allowed to settle and solidify. It has proved to be perfectly watertight, thus allaying the many fears which were expressed as to the possibility of damming the Chagres River and holding back an artificial lake of the great size of Gatun. The difference of elevation of 85 feet between sea level and Gatun Lake is overcome by a flight of three pairs of locks. Each lock is a thousand feet in length and 110 feet in width. When the ship comes to rest alongside of the central pier, which is a 1,000-foot extension of the middle wall of the locks, it is taken in charge by electric towing loco-

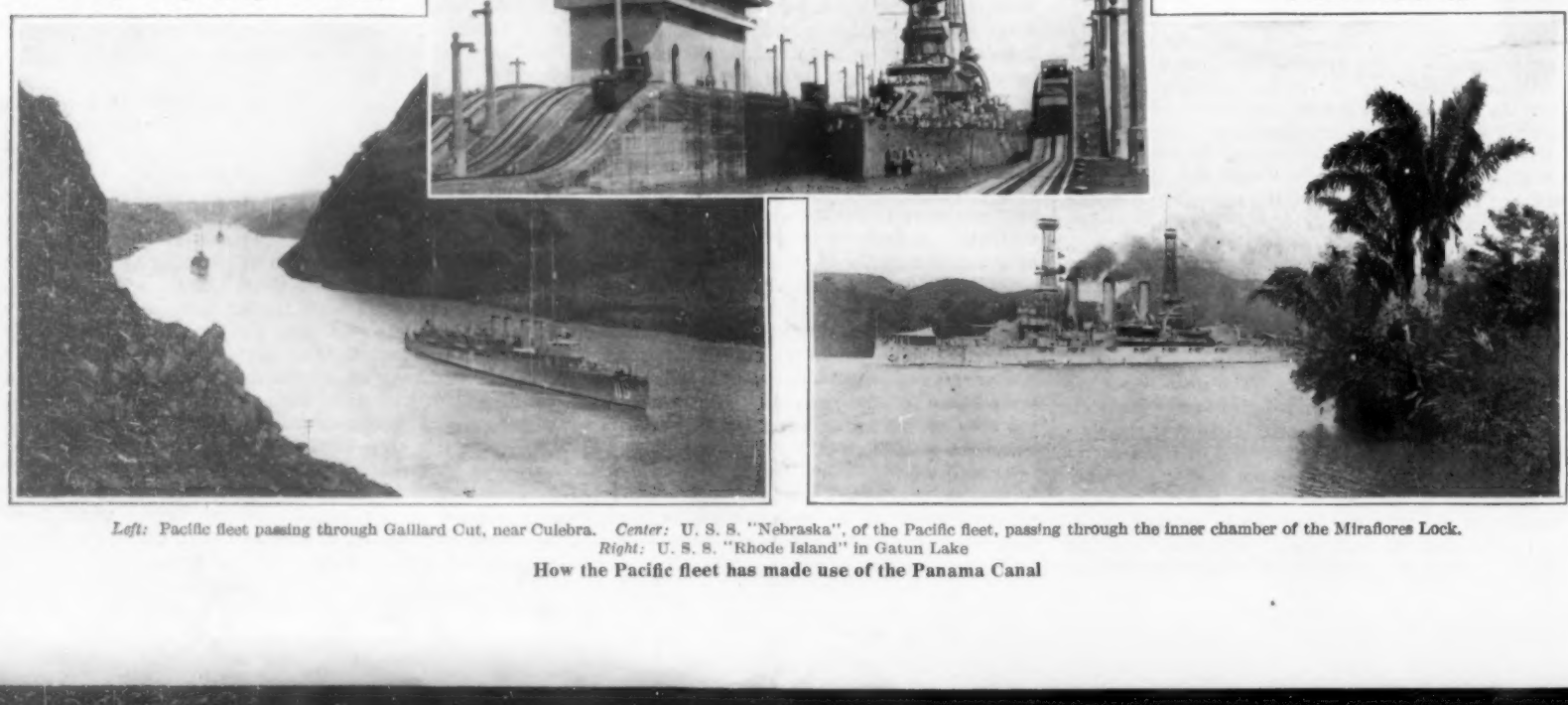
(Continued on page 344)



General view of the Gatun Locks, looking south

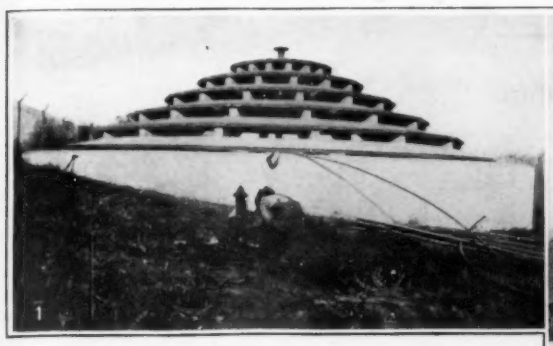


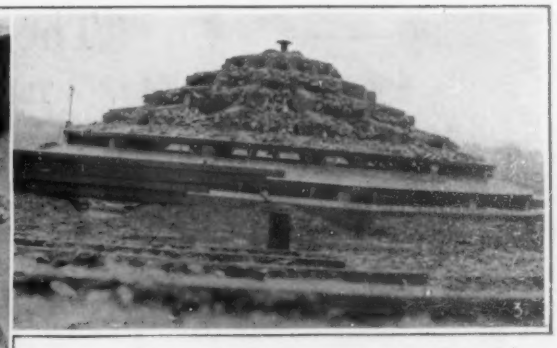
General view of Dry Dock No. 2, Pacific Terminals, from Sosa Hill



Left: Pacific fleet passing through Gaillard Cut, near Culebra. *Center:* U. S. S. "Nebraska", of the Pacific fleet, passing through the inner chamber of the Miraflores Lock. *Right:* U. S. S. "Rhode Island" in Gatun Lake

How the Pacific fleet has made use of the Panama Canal





Left: Concrete cooler before the wrecking operations. *Center:* A section of the wall after it had been drilled and partly blasted. *Right:* Reinforced top of the cooler, as it appeared after being partially demolished by hammers.

Steps in the wrecking of a reinforced concrete water cooler

Wrecking Reinforced Concrete Structures—The Demolishing Art at Its Best

By Leo G. Hall

ONE of the most difficult problems for the wrecker is that of demolishing reinforced concrete structures. The combination of the more or less brittle concrete, which can be blasted or hammered but which cannot be easily cut, with the steel which can be cut, but which in reinforcing form does not yield readily to shocks, renders each of these methods singly unsatisfactory. Usually a combination of two or more of them has to be resorted to with results running high in costs.

The accompanying pictures show a reinforced concrete water cooler which had to be wrecked recently to make room for a new factory at Elizabeth, New Jersey. The first view shows the cooler before wrecking began. The third view shows the thin wire mesh-reinforced top, partially demolished by hammers after some days' arduous work by a gang of laborers. The second view shows a part of the wall after it had been drilled and a few pop-shots been let off.

It will be noticed that the pop-shots had the effect of lifting off the top of the wall above the grip of the vertical reinforcing bars; but in the lower part of the wall, the only effect was to blow off portions of the outer surface, exposing some of the steel, but leaving the main body of the wall sound. It was finally decided to complete the job by cutting the exposed steel with an acetylene flame and taking the wall down in sections. It has been estimated that the cost of wrecking this structure is 20 per cent in excess of the cost of its building; though it must be borne in mind in comparison that labor costs are now about double what they were when it was built.

The writer believes that it would have been better to shoot all of the holes at once, instead of only a few at a time, as was done. In other jobs that he has seen, the effect of shooting a large number of small shots throughout the structure simultaneously, has been to crack the whole mass of the concrete and loosen it from the steel so that knocking it apart by hammers becomes easy. But this method was considered too dangerous to be resorted to here on account of the nearness of surrounding structures.

Greatly enlarged snapshot of the Berliner gyrocopter in actual flight

A Man-Sized Helicopter That Leaves the Ground with Full Load

By George Gaulois

THE helicopter—that type of flying machine which has been the subject of so much ridicule in the past—is about to be realized in a practical form. It is not so long ago that these columns contained a description of the interesting experiments carried out by Messrs. Hewitt and Crocker, with a huge helicopter driven by an electric mitor. And now comes Henry A. Berliner, of Washington, D. C., with a small, one-man helicopter which, in the preliminary tests, has actually left the ground with its pilot and full load. Here, it would seem, is the foundation for a pracitcal helicopter.

It would be useless to review the many attempts at making practical helicopters in the limited space here available, since any reference book contains a more or less complete account. Suffice it to state, however, that we have here to do with the work of father and son—Emile Berliner and Henry A. Berliner of Washington, D. C. Emile Berliner, it will be recalled, was one of the pioneers in the phonograph and telephone fields, and an inventor of note. About the time that the Wright Brothers first succeeded in flying, Emile Berliner took up the problem of the pterophore or helicopter, and towards that purpose he had a Western firm build for him two light-weight revolving cylinder motors, which antedated the famous Gnome and LeRhone motors by some years. In fact, one of these motors is on exhibition at the U. S. National Museum.

In the intervening years between 1908 and the early summer of 1919, Emile Berliner carried on numerous experiments with helicopters and lifting propellers of all kinds, shapes and sizes. His experiments were met with a moderate degree of success; indeed, as early as 1909 one of his helicopters lifted a man from the ground, but such lifting was not steady and was more in jumps and starts. At any rate, Berliner laid the foundation for a practical helicopter, while his son, Henry, was obtaining a store of scientific knowledge and training at the leading engineering institutions of the country, as well as in the aerial service.

The present Berliner helicopter weighs 570 pounds, and is equipped with an 80-horse-power LeRhone rotary engine. The two propellers, driven in opposite directions, are 13 feet in diameter and 10 inches wide, and the total perfectly steady lift has in actual tests proved to be near 900 pounds, or 60 pounds per square foot of *effective* lifting surface. The average airplane has an average lift of only 8 pounds per square foot. The head of the helicopter—or gyrocopter, as the Berliners call their machine—is small, and great forward speed may be expected from it. When the machine is tilted forward it will fly horizontally. The tilting is accomplished by changing the center of lifting pressure. According to Emile Berliner, an inclination of 15 degrees means a lifting loss of less than 3 per cent, and the horizontal push should be about 25 per cent of the lifting power.

Of course, the Berliner helicopter is still in the experimental stage, and much remains to be learned not only as regards refinements in the design but in the whole art of flying such a machine. Emile Berliner has always intended that his gyrocopter should be provided with floats and that in the beginning it should be a water craft, flying low near the surface of rivers, lakes and ocean so that it could quickly descend to safety in case of accident or engine failure. Further developments may result in some means of coming down on land from great heights, just as safely as an airplane does when its motive power fails.

Fighting Crickets with Flame Throwers

IN 1918 and 1919 the territory near the delta of the Rhone suffered greatly from swarms of the Morocco cricket, which multiplied so excessively as to be of great injury to the crops. At a recent meeting of the French Academy of Sciences a report was made by M. Vayssiere on the use of the "flame throwers," employed in the war for throwing liquid fire, to exterminate these pests. With an apparatus holding about twelve liters of petroleum an extent of 200 square meters can be so thoroughly swept with flames as to kill all the insects. Asphyxiating gases had but little effect but applications of powdered chloropicrin were much more satisfactory. While vegetation suffered somewhat the effects were only temporary. Lastly, M. Vayssiere made use of poisoned bait with a basis of arsenic like that employed in Italy and in the United States and obtained good results. He proposes to utilize all three methods—first the flame throwers to exterminate the hordes of young larvae in all cases where their use does not involve danger of fire; secondly, chloropicrin powder where the flame throwers would be dangerous; and thirdly poisoned bait in irrigated meadows where no cattle are pastured.

The Berliner gyrocopter clear of the ground with its pilot, while two mechanics prevent it from getting away

The Romance of Invention—X

The Father of the Lubrication of the Future

By C. H. Claudy

DISCOVERY is merely applied curiosity. How many of our great scientific advances would have been recorded had there not been a man of insatiable curiosity, ready to ask "Why?" and ask it again and again until he found the answer? Indeed, the difference between scientists and great scientists might be said to lie in the degree of imagination shown in seeking out unthought-of places for this question. Dr. Acheson, whose story Mr. Claudy tells us this week, avers that he was put on the trail of his greatest discovery by applying this scientific curiosity to an incident related in the Bible—surely a sufficiently unusual place to seek the groundwork for a triumph of applied science! But the man of imagination will find scientific questions raised in the Bible as well as anywhere else, and it was indeed in pondering one of these—Why were the Jews unable to make bricks without straw?—that Dr. Acheson opened the way to what he confidently expects to be the lubrication process of future generations.—THE EDITOR.

"SO the people were scattered abroad throughout all the land of Egypt to gather stubble instead of straw."

The curious may find that quotation in the fifth chapter of Exodus. But none may say why it was that generations after generations of men should read that verse from the Bible—indeed, the whole fifth chapter of Exodus—and read it without understanding what its interpretation might come to mean to the world.

Nay, gentle reader, the SCIENTIFIC AMERICAN is not engaging in religious discussion nor is this a theological article. There have been few more picturesque stories published in this or in any publication than that one which is concerned with the establishment of a giant industry, the making of an epochal discovery and the very probable conservation of millions of horse-power, untold tons of coal and barrels of oil, through the interpretation of a verse in the Bible which had had only a parable-like translation in the mouths of those whose work it is to interpret the Word.

Comparisons are often as invidious as they are odious. No comparison is intended when the statement is made that America has no more distinguished electro-chemist than Edward G. Acheson. But there will be none to dispute the statement that no electro-chemist has produced greater industrial revolution or created greater industries through his discoveries, than this same Acheson.

If there were space the oft-told story of Acheson's life might here be told again—the poor boy who sticks to the job, the discouraged inventor who refuses to be beaten, the out-of-luck pioneer who is derided, laughed at, scorned by his superiors and wins out in spite of them, is always a good journalistic tale. Luckily for the present writer and perhaps even more luckily for the subject of his sketch, there is no need here to write even a thumb nail biography such as has been written time and again about Dr. Acheson.

More interesting even, than an interesting life, is the inside story of what he believes to be the greatest of his discoveries—a fine mouthful of a word you shall find in no dictionary, "deflocculation."

The chances are you never heard of it. But you never heard of Hertz until Marconi mastered wireless. . . . Bell coined "telephone" as a word years before you ever used one, and "carborundum" was the best abrasive in the world for years before any but jewelers would admit it. The world is to become as familiar with the thing for which "deflocculation" stands as it is now familiar with radio, airplane, X-ray, and a dozen other wonders of this era of mankind.

Suppose some magician gave a man the power to magnify material in fact as we may magnify it in appearance under the microscope. If we used that power, we might take the smallest possible fleck of soot we could pick up on the finest needle point, and magnify it until it was a sphere or a lump several feet in diameter. Suppose then, we crushed this lump into particles, each particle as small as the original particle we magnified. Suppose once more and for the last time, we removed the magnifying power and let these tiny particles shrink in proportion as the parent mass was magnified.

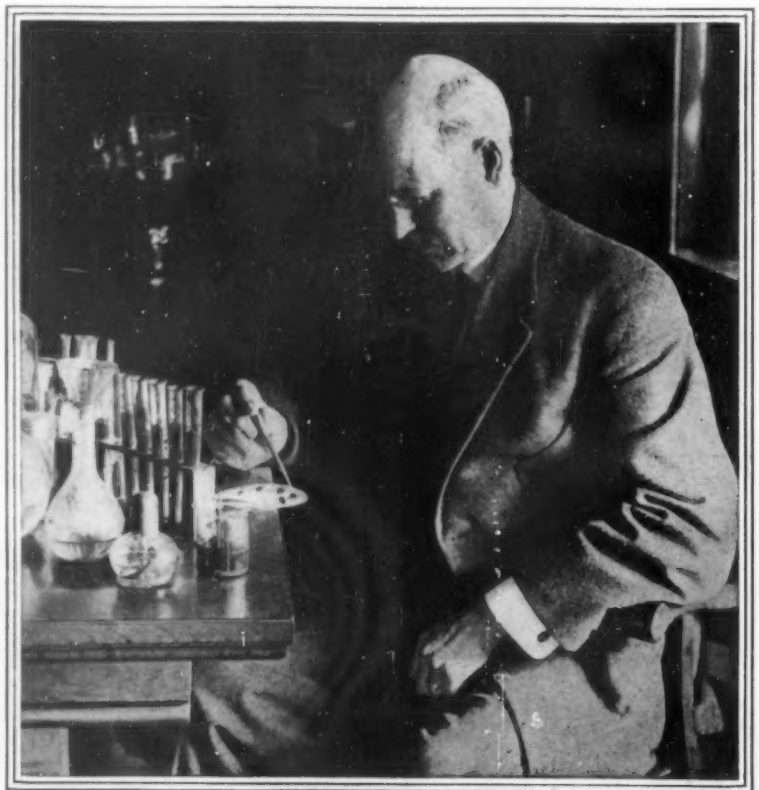
They would be rather small, would they not?

Something like that is the result of the process of deflocculation, in which the very small particles of matter to which the process is applied are made smaller and smaller and again smaller by a process of continual division and subdivision and resubdivision—to just what point even the inventor will not state. But deflocculated particles are so small that they seemingly must approach the molecule in actual size; so small that they defy the ordinary laws of gravity as if those laws were mere figments of the imagination.

It was this process the germ of which lay in the inability of the captives in Egypt to make good bricks without either straw or stubble.

Neither straw nor stubble have any strength of their own. They cannot be binders of brick-clay. Yet straw or stubble was a necessity for the making of Egyptian bricks. That was the starting point from which Dr. Acheson argued. It seems obvious enough now, that if it wasn't the straw or stubble itself, it must be something *in* straw or stubble which made clay produce good bricks.

Dr. Acheson knew that of two clays, one residual, one sedimentary, the latter was far stronger when made into pottery (crucibles, for instance) than the former. And chemical analysis failed to distinguish differences which would account for the fact, just as chemical analysis failed to account for the reason why German clays have greater plasticity and tensile strength than many American clays.



Edward G. Acheson—the man who made carborundum famous, and established graphite as a lubricant

Apparently the main difference between residual and sedimentary clays is that one has been carried from one place to another, by water. Was it something *in* the water which worked a change in the *physical* structure of the clay that made one good, the other poor, for making things?

For thousands of years men have worked in clay and read the Bible, and yet no one caught the flash which Dr. Acheson saw. He went to the fields, got a grip full of straw, weighed it, boiled it, reweighed it, found it had lost half its weight, took the water from the boiling, mixed it with clay, made a crucible of that clay—and had an infinitely better and stronger vessel than the same clay would make if not mixed with straw water.

From this beginning came further experiments, and the remarkable studies which have given deflocculation as a process to the world. It stands for the ability of certain vegetable extracts to divide and divide and divide again tiny particles of matter suspended in liquid, to a point where they pass through any filter paper, remain suspended as if removed from the action of gravity entirely, and of a size where they defy the microscope to make them visible, although the ultra-microscope shows them as minute points of light.

The importance of this discovery may not be evident to the casual reader. But that it is vitally important to all industry, Dr. Acheson believes, and he brings forward a wealth of statistics and information in support of that belief. Among his other synthetic products from the electric furnace, of which carborundum, the abrasive made by subjecting coke and sand to a high temperature in the electric arc, is the best known, is a synthetic graphite of remarkable purity. This graphite, when deflocculated, produces a lubricating substance of such quality and character as to make it not only a competitor of all other forms of lubrication but apparently the thing which is destined to enable the wheels of the world to turn.

For it is upon lubrication, not upon their bearings, that all wheels do turn. Take away our gasoline and we may substitute alcohol, eliminate our coal and we may use water power as a substitute, burn up all our wood and we will grow more, but take away our lubricating oil and every wheel in the world must shortly cease in its revolution.

Artificial lubricants have been sought for years with ill success. Now comes deflocculated graphite, believed by its discoverer to be the coming lubricant, and already demonstrating its power, when used with lubricating oils, to conserve their powers and lengthen their life.

In an oil test made in an oil-testing machine, which is but a shaft and bearing so constructed that the required horse-power to move the shaft in the bearing, the load of which is known, can be measured, tests have been made of the old and the new lubricants, side by side. Too many to quote here in detail, one may be mentioned. With a certain pressure on the bearing, it was required that eight drops of the best lubricating oil be dropped in the bearing every minute. Reducing the oil to seven drops per minute, the bearing "froze." Under identical conditions, the bearing was sufficiently lubricated with *one* drop every *two* minutes of the *same* lubricating oil, when it contained a minute quantity of deflocculated graphite in suspension—one *sixteenth* as much.

It is provable by tests that an average of fifty per cent of the power in practically all industrial establishments goes to waste in heat, caused by friction. A man has a hundred horse-power prime mover but ob-

(*Continued on page 346*)

Testing Airplane Propellers

The Establishment at McCook Field Where the Aviation Service Does This On a Large Scale

IN its infancy aviation was almost wholly an empirical art, one governed by rule-of-thumb methods. If it was desired to know whether a given design would fly, the one answer was "Try it and see." The reason for this was not alone the lack of exact knowledge of why and how airplanes fly and of the laws that govern their sustention and propulsion; it arose equally from the fact that performance was outstripping experiment. There were at best the most ridiculously inadequate facilities for formal test; while we were talking about how we should test a wing structure or a novel assembly of flying members, the thing was put together and used in attempted actual flight. But today, with aerodynamical laboratories and wind tunnels on every hand, this is no longer the case; and we are able to learn without anything resembling actual flight a great deal about flight and the means of flight.

One of the most complete and most interesting of the many places at which aeronautical tests are made is the propeller-testing laboratory at McCook Field, in Dayton. This plant, we learn in a lengthy article in the SCIENTIFIC AMERICAN MONTHLY for March, was erected to safeguard the experimental propellers against the possibility of failure in the air, and at the same time to make tests of promising inventions and designs. Anyone who has seen a bad propeller failure does not need to be told of the results. It is only necessary to imagine an unbalanced centrifugal force of 15 tons resulting from the loss of one of the blades; with this load changing its direction with each revolution it is only a matter of good fortune if the whole machine is not wrecked. And while such failures have been rare indeed in the army service, they do happen. Moreover, aviation is not standing still and every once in so often it is necessary to try something that seems good but has not been tried before. It is altogether desirable to make this trial on the ground rather than in the air.

The precautions taken to safeguard the observers are notable. The dynamometer that runs the propeller during a test is housed in a conical structure shaped much like the nose of a bullet. This stands on a heavy armor-plated floor, with a series of narrow slots cut in it. The observers stand beneath this floor, and look up through these slots at the rotating propeller. If under these circumstances the propeller were to fail, there would be a general smash-up of propeller and part of its housing; and small fragments of the wreckage would be driven through the slots on the side where the propeller is moving downward in its rotation. So on this side there are no slots; the observers are placed at the side on which the propeller rotates upward. Of course, the observers are not asked to watch the propeller with the naked eye; that would be quite absurd. A well mounted set of telescopic observing instruments is provided in the pit beneath the propeller housing; and with telescope and mirror it is easy for the watchers to keep track of the whirling blade and detect any irregularities in its speed and plane of rotation.

The transit telescope here is provided with a mirror set at 45 degrees so that the revolving propeller may be seen through the slot by looking through the horizontally placed telescope. The sliding ways on which the latter is mounted are set up exactly parallel to the axis of the propeller shaft. Thus the telescope is exactly parallel to the plane of revolution of any radial element of the propeller. While the propeller is turning over at idling speed the telescope is adjusted until the cross-hair is exactly in the plane of revolution of, say, the leading edge. The position of the telescope is then noted on the scale. When the speed is increased the adjustment is repeated and the difference in position, subject to a correction due to movement of the shaft, gives the deflection of the blade at the speed in question. By proper combination of several readings the pitch variation may be got; and a method is being worked out whereby a separate test may be made of each half of the propeller, instead, as at present, of a single reading which represents an average for the two sides.

Another test of great importance is the water-spray one. It will be remembered that at flying speeds the bombardment of the propeller blades by the drops of a rain-storm is almost as severe as though enemy bullets instead of drops of water were flying through the air and impinging upon the blades. We have heard tales of a machine that barely struggled to the ground, all but helpless, after fifteen minutes of hard rain—with the propeller honeycombed through and through by the flying drops—drops with an effective velocity equal to the speed in its path of the blade. If we assume an average speed for the propeller of 1,200 revolutions per minute, and an average propeller length (for two blades together; *i. e.*, the diameter of the circle, not the radius) of eight feet, the propeller tip travels in its circle at a speed of nearly 10,000 feet per second. There are places on the blade for which at certain instants this rotation speed is in practically the same direction as the forward speed of the plane. If to the composition of velocities thus effected we add the possibility of the wind blowing hard from dead ahead, it is not at all out of the question for raindrops to hit the blade with an effective velocity up to five miles per minute. So it is no wonder that they eat in; and to guard against this, the propeller must be as nearly impenetrable as possible.

For the water-spray test, water is supplied from an overhead pipe at the top of the bomb-proof housing. By regulating the amount of the water and the pressure, the speed of the propeller, and the duration of the test, this trial may be made as exacting as desired.

Some interesting and important theoretical matters get a good deal of light from the propeller tests carried out in the manner outlined. Thus, if as might seem eminently reasonable *a priori* the thrust and the torque were both proportional to the square of the angular velocity (*i. e.*, the revolutions per minute), the ratio between thrust and torque would of course be constant. But the tests show that ratio of thrust to torque decreases after the speed of 1,000 revolutions per minute (with a certain type of propeller employed

(*Continued on page 348*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Armor, Speed and Freeboard in Battleships

To the Editor of the SCIENTIFIC AMERICAN:

Referring to Mr. Van Blarcom's argument *i. e.* Speed vs. Armor (SCIENTIFIC AMERICAN, Jan. 24, 1920), I wish to state the following facts, of which I have first-hand information:

Mr. Van Blarcom states that no armor can stop a 14-inch shell at anything near fighting range. Now, I know of one case, at least, when but 6 inches of armor stopped a 15-inch shell most effectively. That was on the German battle-cruiser "Moltke" during the great battle of the North Sea mentioned by Mr. Van Blarcom.

The forward turret of the "Moltke" was hit by a 15-inch shell, and though the turret is protected by only 150 millimeters of armor, the shell did not penetrate, but fell on the deck without exploding. It did no damage besides denting and cracking the plate.

More than one 15-inch shell was found stuck in the main armor of the large German ships of the Koenig-class, and in several cases large holes were torn into the armor by shells which exploded after getting stuck in it, without doing great damage to the ship's interior.

I suppose that in battle conditions shells coming at an angle will often be stopped by or will glance off of armor they would easily penetrate if they had hit it squarely. That may account for the cases above mentioned.

It seems to me that the examples cited above are sufficient to justify the practice of arming ships to as great an extent as is compatible with a satisfactory speed, though, of course, Mr. Van Blarcom's statement that a battleship's speed should be as high as possible is universally recognized as correct.

I again refer to the German battle-cruisers in the question of a low freeboard. These ships are extremely low, both forward and aft, and (as the SCIENTIFIC AMERICAN has correctly pointed out) they do not possess the main property a battleship should have, viz., the ability to fight under all circumstances. The forward turret of the "Moltke," for instance, was often flooded by seas which entered through the gun-ports and through the guns themselves. Also, the forward deck of this ship is continuously awash when the ship is running at top speed. A high sea is not even necessary to cause this condition, which obviously is far from ideal.

Besides, the hull of a battleship above the waterline does not contain any apparatus that is essential for maintaining the ship's speed or fighting ability (excluding gun-turrets and the various means of command and communication, which would have to protrude on a low-decked vessel just as well), and therefore the higher ship is not at a great disadvantage, even though it does provide a larger target for the enemy's artillery.

It seems that this is borne out by the fact that all of the German ships that were sunk in the battle of Jutland had light armor, and that the heavily armored ships of the more modern classes were able to make port under their own steam, though they were completely riddled above the water-line, and, in some cases, razed to the deck.

We can conclude that the heavy armor of the German ships saved them from complete destruction, and that a high deck was not found to be a great disadvantage.

If we consider the damage done on English ships, we have the difficulty to contend with that a large number of the English battle-cruisers were in the fight but a comparatively short time. If we take that into consideration, it seems that the damage done on those cruisers was much greater than that done on the heavily-armored super-dreadnoughts.

Mr. Van Blarcom's idea of shell-spotting does not seem to me to be practicable. Balloons have frequently been brought down in the recent war that were extensively protected by "Archies" firmly planted on good, solid ground, and I do not see why the odds should be in favor of the anti-aircraft-gunner at sea. The ship will obviously be always ahead of the trailing balloon, and an enemy airplane would have a splendid line of approach if it kept the balloon between the protecting warship and itself. Other ships could of course, interfere with the airplane, but it seems to me that the airplane has still much greater odds in its favor than it had in the recent war. The fact that such a small balloon can easily be hauled down at a rapid rate does not alter conditions very much, since a ship relying exclusively on such a balloon for shell-spotting would have to go without that very important feature every time an enemy airplane approached.

It seems, therefore, that a good battleship should comprise the following features:

Heavy armament, both defensive and offensive.

High speed.

Large freeboard (to be assured of good sea-going qualities) and high fighting-tops (to insure efficient shell-spotting).

Of course, these features must be compromised to a certain extent, and just what features should be preferred is largely a matter of opinion.

Our own Naval authorities are, I believe, more competent than anyone else to settle that matter, and if they find a heavy armor, a high freeboard, and high fighting-tops necessary, I should think that would convince anybody. HEMING B. DIETER.

Austin, Tex.

Reversal of Image in Photography

To the Editor of the SCIENTIFIC AMERICAN:

The article under the above title in your issue of February 7th interested me. I have had a lot of experience in view photography, and never saw or heard of a "Reversal of Image" on the exposed plate or film. I have exposed and developed a lot of plates and films, over and under exposed, as well as some double exposures, but never saw one with the image reversed, and the more I study over the matter, the more complex it becomes. I can hardly accept the over-exposed plate as the correct solution for making positives on the film side of an exposed plate with the usual photo lens, because it is the lens that reverses the image on the plate, upside down, right to left, and unless the image is re-crossed between the lens and plate, how could it be produced right side up, regardless of stops or length of exposure? W. L. SALVAGE.

Beaumont, Cal.

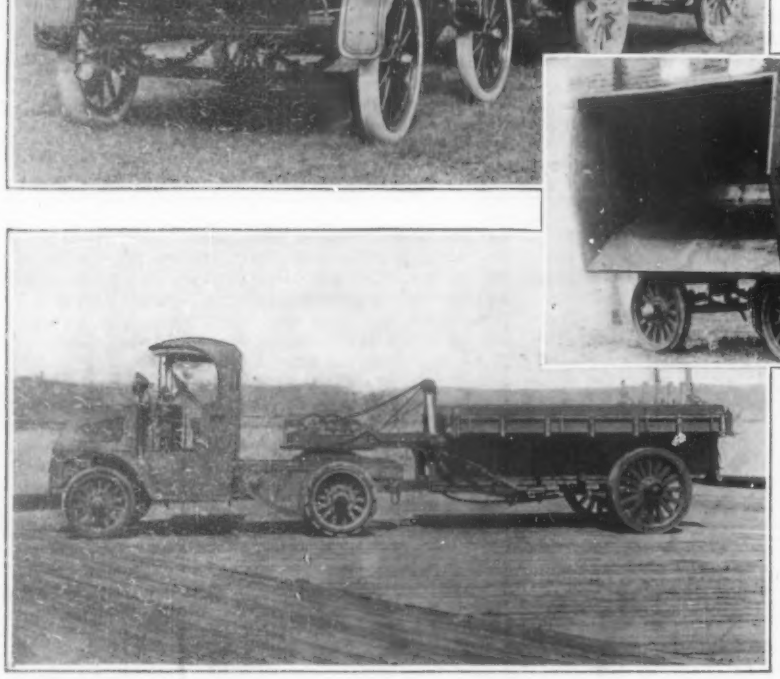
Why the Trailer Has Made Good

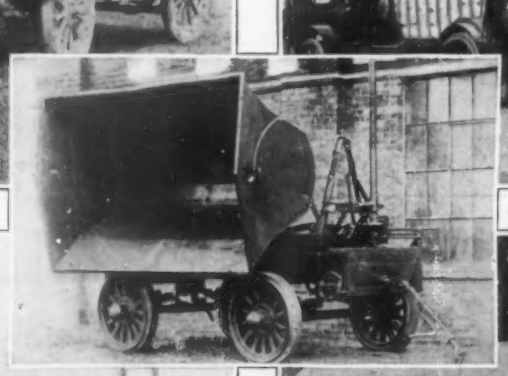
Some Points Connected with Its History and Its Current Use with Motor Trucks and Tractors

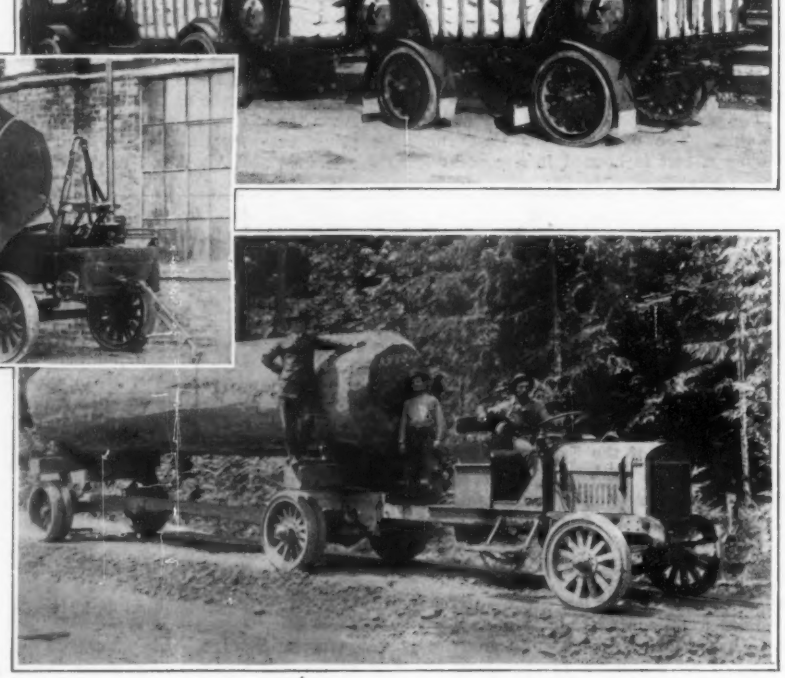
By Howard Greene

TRAILER evolution has its place in vehicle history just as has the evolution of the motor truck, and the gap that separates the trailer of today from its ultimate ancestor—from the crude device which involved the first application of the principle—is greater than that which separates the motor truck of today from the first self-propelled road wagons.

Away back—no one knows just how far—primitive man discovered that his horse could pull more than he could carry. So a couple of poles were slung from the beast's sides with the ends trailing on the ground, and the load placed across the poles. This probably constituted the first trailer outfit unless, indeed, the man himself antedated it by taking the front ends of the poles in his hands or slinging them from his shoulders or from the shoulders of his squaw. And it may be pointed out that this involved the principle of the modern semi-trailer, in which the load-carrying part







Above, left: A one-ton four-wheel trailer for miscellaneous use with the passenger automobile. *Right:* A five-ton truck walking away with a 12-ton load, half of which is carried by the trailer. *Center:* A five-ton trailer with special type of dump-body. *Below, left:* Fifteen-ton tractor hauling semi-trailer of goose-neck type with dump-body. *Right:* Logging semi-trailer in service in Oregon; the load contains 3,880 board feet of airplane timber.

Some representative trailer designs and their application to divers fields of work

trucks were for the most part wagons that had been put out of service when the motor replaced the horse. The owners wanted to handle a little more stuff, and at the same time they had a perfectly natural desire to realize something on the original investment in wagons and wagon equipment.

While this helped greatly in bringing about a realization of the possibilities of the trailer, it also indicated that a wagon built to travel at horse speed was out of its class when hauled at the normal rate maintained by a motor truck. Especially was this the case with vehicles carrying heavy loads. Wheel bearings heated and wore rapidly when speed was doubled—more rapidly than could be accounted for by the mere increase in mileage. Vibration made trouble that was unknown when the motive power was supplied by horses. Steel tires were battered out of shape, became loose on the wheels or split at the welds. Wheels hauled by a motor truck or by a special tractor than it ever was with any other form of power for road service—that is, under proper conditions. What makes the trailer as practical as it is is the fact that the truck is built with sufficient power to handle its normal load under abnormal conditions, and therefore it has a very considerable excess of power for ordinary work. So when a trailer with its extra load is coupled on the engine is asked only to develop a part of its extra power, and not a very large part of that. Generally speaking, a truck carrying its normal load and hauling a trailer with an equal load—a total of double the normal load of the truck—will show an increased consumption of gasoline and oil of about twenty per cent. To this must be added a little extra wear and tear and general deterioration. As, however, the truck is still working far within its normal limits, the item is by no means a serious one, and it has been found

of the outfit is carried partly on the tractor and partly on its own rear wheels.

Coming down to wheeled vehicles, it may be said that the trailer is as old as the wagon or cart itself. Very early it was discovered that horses could, under favorable conditions, handle bigger loads with a wagon and a trailer than with a wagon alone, and so it has come to pass that trailers have had their place in transportation practically since transportation began.

In the evolution of the trailer the fact stands out that like begets like. As a load carrier the horse or pony was a crude sort of thing, and the pole-trailer or "travois" was the acme of simplicity and inefficiency—but it worked. When horse-drawn wagons first hauled trailers they were simply other wagons, or, a little later, trailers built on wagon lines pure and simple, with plain bearings and no small amount of unnecessary weight—that is, unnecessary from the modern point of view. The first trailers hauled by motor deteriorated under the strain. In fact, speeding up the wagon in this way was not an economical proceeding *per se*, however well it served for the moment.

Then manufacturers began to take up the trailer question seriously. They studied the faults of the wagon; they built improved types of trailers and tested them out. They found troubles and eliminated them. Not content with this, they continued the process of refinement until, to make a long story short, the trailer as we have it today is a highly specialized piece of engineering, and its manufacture has brought forth a separate branch of industry, banded closely together for the common good and for the better development of its product. It may be taken for granted, then, that the trailer is something far more than an improved wagon hauled behind a motor truck, and in contemplating its use it is necessary to consider it on its own merits.

The trailer is a better vehicle, a better load carrier, a more economical means of transportation, when that the actual difference in the life of a truck hauling a trailer to that of a similar truck carrying only its normal load is so slight as to be much more than discounted by the gain in time and over-all efficiency.

It goes without saying that there are conditions that preclude the use of trailers. If roads are so bad and hills so steep that the truck is taxed to its normal limit to handle its rated load, the addition of a trailer will lead only to trouble—severe strains, undue wear and tear, engine and tire trouble and so on. In hauling a trailer it is essential that the normal limitations of the truck, as specified by the manufacturer, should be observed. It is impossible to work a truck—or any other machine, for that matter—constantly at its limit of power, or close to its limit of power, without causing it to manifest symptoms of ditsress early in its life and to go to pieces altogether too soon—probably before it has paid for itself.

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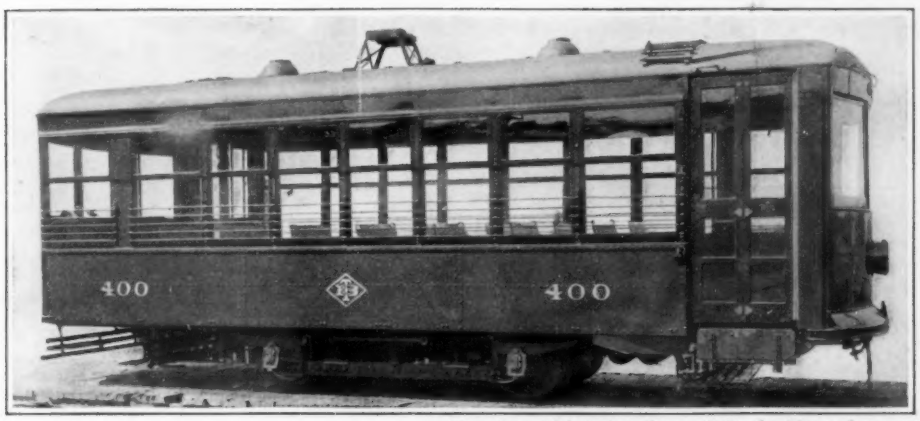
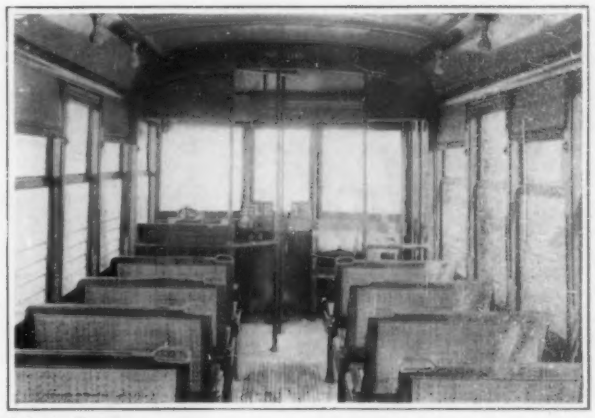




Exterior and interior views of the double-end one-man safety trolley car

One-Man Trolley That Runs on Short Headway

TRACTION lines are today in distress, both through financial difficulties directly connected with their own operating problems, and through the extreme inroads which jitney competition has made on their traffic. No effort to solve one of these troubles will be of avail unless it at the same time attacks the other. This means that the trolley companies must seek a car which can be operated at less cost and at greater speed with smaller headway. An effort to combine these two requirements is shown in the car illustrated herewith.

The car shown is operated by one man, who discharges the duties of motorman and conductor. The fact that the rear platform is never used makes it possible to dispense with the left-hand door at each end of the car; no matter which end of the car precedes, the necessary door at the right of the operative is there. For heavy urban traffic, where separate entrance and exit is desired, the car illustrated would hardly serve, since the rear door is on the wrong side and could not be used; but it is not designed for such service in the first place, and could easily be modified for it in the second. For the purpose for which it is intended, it presents, by reason of the absence of two doors, constructional as well as operating economies.

These cars weigh approximately 8 tons, and to this unusually light weight is attributed a marked economy in power consumption. The motor equipment is designed with an eye to rapid acceleration and deceleration, the latter of course being aided even more than the former by the light weight of the car itself—this helps the motor in starting, but even more it helps the brakes in stopping. If the distance over which the slow-down for stopping and starting extends can be cut fifty per cent, there is a very real speeding-up of schedules and a saving of time for the passengers.

The idea of the manufacturer of the one-man safety car is that it shall be run on a short headway—preferably on a basis of three of these cars for two of the older two-man kind. The reduction in headway thus effected furnishes an added attraction to the car-using public not alone on its own grounds, but because in

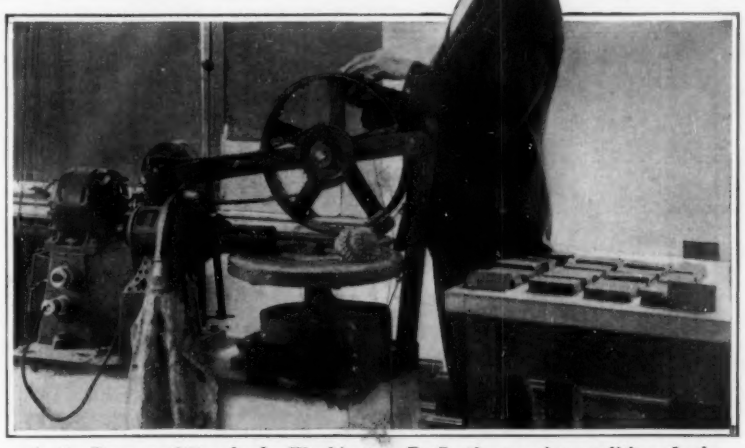
(*Continued on page 350*)

Measuring the Wear of Shoe Soles

THE Bureau of Standards has developed a machine for testing the durability of sole leather. The leather is subjected to shearing action during the test similar to that which happens to shoes in actual service. The machine will indicate in about 24 hours of operation the durability of the specimen.

A wheel of 15-inch diameter carries on its face 12 test pieces. The wheel revolves at the rate of 30 revolutions per minute about a horizontal axis with its bearings in two parallel metal bars, each of which is pivoted at one end, the other end being free. The wheel which carries the weight of the bars rests on a horizontal disk of 16-inch diameter. The point of contact is 5½ inches from the axis of the disk. The disk has a surface of carborundum, and rotates about a vertical axis on which is a brake wheel provided with a brake strap. A chain drives the wheel and in turn drives the horizontal disk. A test usually consists of 40,000 revolutions of the wheel. This corresopnds with 40,000 steps or approximately 40 miles of walking. A small suction fan removes the dust caused by abrasion.

Many tests have been made upon this machine, including the relative durability of artificial substitutes for sole leather and the relative durability of sole leather from various parts of the hide. In the latter test specimens were taken from 72 positions on the hide and the durability was determined in terms of volume abraded by this machine.—By *Allen P. Child.*

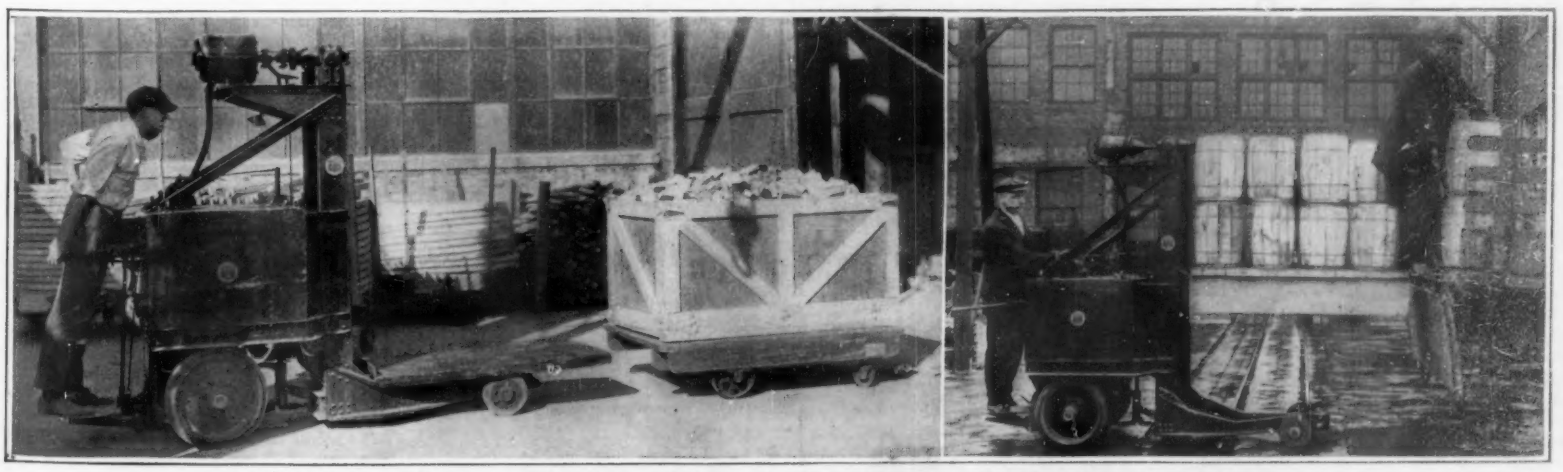


In the Bureau of Standards, Washington, D. C., the wearing qualities of sole leather are determined with this machine

The Truck that Delivers Its Load

THERE has long been the need for an industrial truck which would quickly and economically pick up and carry a load to its destination, then elevate that load to the desired height for easy loading, or final storage. The truck shown meets this need. It is an electric storage battery truck, with a lift platform upon which a 4,000-pound load may be placed and elevated to a height of 76 inches, or to any intermediate height. The lift motor is an entirely separate and independent unit, a 24-volt, 40-ampere series-wound high-efficiency motor of ample overload capacity to lift the maximum loads with an ample factor of safety. The truck has three speeds both forward and reverse, the drive motor being a 24-volt, 60-ampere, series-wound unit. It has a four-wheel-steer which permits it to turn in a circle of 92-inch radius. This allows ease of operation in narrow aisles, freight cars, loading platforms and any congested parts of the plant.

This little truck lends itself to a wide range of usefulness: equally well does it work for the manufacturer, in the machine shop or freight station. With the high lift, loaded platforms may be placed on shelves or in racks 75 inches above the floor: heavy castings, forgings, dies, etc., may be elevated to the level of the machine tool table and the rehandling by crane eliminated. These same loads may be elevated and piled in stock or storeroom upon regular shelving designed to receive them, thus very materially increasing storage space. Trucks and railroad trains may be loaded from the ground and rail level. The amount of handling saved in loading and unloading from the truck with this apparatus can be better imagined than estimated. In these days of scarcity of labor, when production and distribution costs are soaring, a truck of this design comes as a boon.—By *Grace Orb.*



This little electric truck not only carries its load about the plant, but it lifts and lowers it for loading and unloading purposes

The Latest Word in Steel

How Molybdenum Has Gained a Place Among the Foremost of Alloying Agents

By W. Norman Bratton, Metallurgical and Mining Engineer

DEVELOPED by the stress of war, a practical, new alloy steel has come into commercial being, possessed of qualities that forecast sweeping changes in many industries where a steel combining lightness and strength is required.

Molybdenum (mo-lyb'-den-um) steel, known to American metallurgists for some years, is making its appearance on the market in commercial quantities. Several grades for various purposes have been developed after successful use employing scores of thousands of tons. These are today being marketed by three of the largest steel manufacturers in the country and more than a dozen others are starting to deal in them.

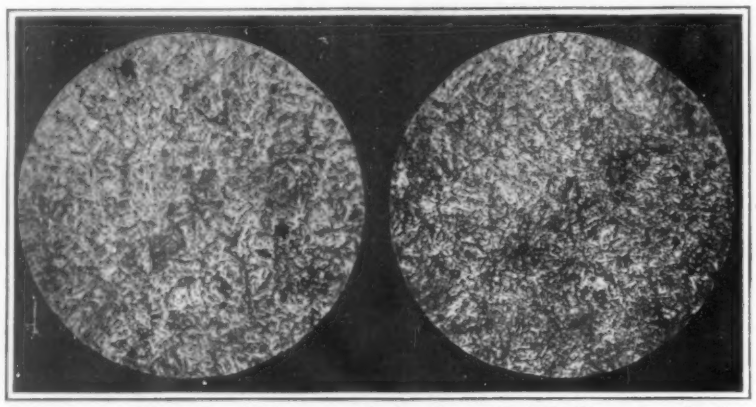
Makers of automobiles, trucks, tractors, airplanes and parts used in automotive industries, makers of forgings of all kinds, of springs and of gears, are most directly concerned in the development of molybdenum steel. Such manufacturers are hailing molybdenum steel with real interest. To them, because it has the greatest available strength of any alloy steel, its use means a reduction in the weight of machines through the possible decrease in the size of machine parts without loss of strength.

The greatest significance of molybdenum steel to American manufacturers, however, is that the discovery of the molybdenum ore deposits in Climax, Colorado, and the use of this ore in producing a new steel alloy on a commercial scale, assures the United States of world independence in the production of high grade alloy steels. The Colorado deposits of molybdenum represent from 60 to 80 per cent of the world's supply. The mines there, tapping the proverbial "mountain of ore," are already developed to 1,000 tons of ore a day, and have not attained as yet anything like maximum production.

This is the age of steel alloys and in this age steel manufacturers are dependent on five alloying elements—nickel, chromium, tungsten, vanadium and molybdenum. They are the chief alloys that have been proved commercially practical. And only now are manufacturers learning what the war has taught of the tremendous possibilities of molybdenum steel.

The United States is compelled to import practically all of its nickel, vanadium, and chromium used in the steel industry. Tungsten and chromium while mined in this country, are far from plentiful here; before long the former, too, must be imported. Thus for four of the five alloying elements, the United States is dependent on foreign supply. But of molybdenum ore, we have a practical monopoly. If American manufacturers are ever shut off from their imported supply of nickel, chromium, vanadium, or tungsten, they will still be in a position to manufacture alloy steel that will not only compare well with steel of other manufacture, but even surpass it in many respects.

Great stimulus to the development of molybdenum steel was given by the need of a light, tough steel for use as armor plate for fighting tanks, for helmets, and for gun shields, as well as for crank shafts and connecting rods for airplanes. Previous to the rise of these military exigencies, experiments with molybdenum as an alloy for toughening steel were already under way. But small quantities were involved in the tests, and results, although encouraging, had not progressed to the point of producing molybdenum commercially. Many authorities thought they never would. However, the romance of molybdenum began almost simultaneously with the outbreak of the World War. For it was about that time that the great Colorado deposits were discovered and their development begun.



Transverse sections of molybdenum, etched and magnified 400 diameters, showing texture at 350 degrees and 1300 degrees Fahrenheit, respectively

Results of tensile test on molybdenum steels of similar grade, subjected to various heat treatments

Drawing Temperature	Elastic Limit lbs. per sq. in.	Tensile Strength lbs. per sq. in.	Elongation Per cent	Reduction of Area Per cent	Brinell Hardness
500° F.	248,700	254,400	12.0	49.7	477
600° F.	236,100	243,100	12.0	50.7	464
700° F.	219,300	229,300	12.0	52.2	452
800° F.	199,000	210,300	12.0	52.8	433
900° F.	185,300	196,300	13.5	53.4	395

NOT more than four years ago, the SCIENTIFIC AMERICAN *had occasion to ask a prominent metallurgist what he thought of molybdenum steel. This man, a recognized authority in the field of alloy steels, replied over his signature that molybdenum was an exploded bubble; that there was no future before it at all. It was his belief that anything which molybdenum would do, tungsten or nickel or chromium or vanadium or manganese would do better and more cheaply. And his opinion was representative of the generally accepted viewpoint.*

It is a dramatic story how in the press of war-time necessity molybdenum got a chance to reverse this verdict—and reversed it squarely. Molybdenum today has more than made good—it has taken an unquestioned place in the very front rank of steel alloys. If it is not obvious that a process which gives to steel the properties outlined in the above table has passed the acid test with flying colors, the detailed story which is told on this page will make it clear that such is the fact.—THE EDITOR.

A molybdenum mine and mill located in the heart of Colorado and now being put into big production

Almost immediately, pioneer seekers for a super-steel resumed experiments with new spirit and on a much larger scale. Their striking success has resulted in putting molybdenum on the steel market. Molybdenum flew over German troops in the motors of Allied airplanes. Molybdenum helped repel the terrific impact of high-powered, armor-piercing German ammunition as part of the armor plate of the French baby tanks. Later molybdenum played its part, again in the crank shafts and connecting rods of a Liberty motor, when the gallant NC-4 spanned the Atlantic.

These worthy achievements for purposes of war have stimulated steel manufacturers to turn the sword into a plow share; to utilize for purposes of peace this new alloy which proved its worth so well in machines of war. As has been said, molybdenum steel has the greatest available strength of any of the alloy steels. It has the greatest width of temperature range within which steels can be both hardened and tempered. It is the most easily machined of any alloy steels treated to given elastic limits.

The practical results of these attributes are many. It is predicted that a 25 to 33 per cent reduction in the weight of automobiles will be permitted through molybdenum steel's superior strength and resistance to shock and fatigue. The mileage of a gallon of gasoline will increase. Lighter engines can be used to drive the customary loads of today at higher speeds than now in vogue.

One of the outstanding metallurgical achievements of the war was the molybdenum-chrome-nickel steel used in Liberty motor parts in quantity. It possessed dynamic and physical properties together with exceptional machining qualities previously unattainable. Again, molybdenum came to the front when a lighter armor was sought for tanks. The cast manganese-steel turrets and gun-protectors had proved too heavy and too cumbersome with their three-inch walls. They were also quite ineffective when facing German ammunition which penetrated and often passed entirely through the turrets. The incredulity of French engineers, therefore, can be imagined when an American manufacturer evolved a turret and gun protector of flanged and formed armor plate that ranged in thickness from one-quarter to five-eighths of an inch. Nickel-molybdenum and chrome-molybdenum steels were used in this case, and it is these types which are being projected for airplane, automobile, truck and tractor parts.

Molybdenum is a metallic element which, in ore form, is very similar in appearance to graphite. At the flotation mill at the Colorado mine, molybdenum ore is ground and concentrated by oil flotation into concentrates of from 60 to 70 per cent MoS_2, which are then converted into ferro-molybdenum or calcium molybdate.

There are four distinct molybdenum steel types: chrome-molybdenum, subdivided into grades according to their carbon and chromium content and again classified according to the molybdenum content; chrome-nickel-molybdenum; nickel-molybdenum; and chrome-vanadium-molybdenum.

In all of these types there is no greater percentage of molybdenum than one per

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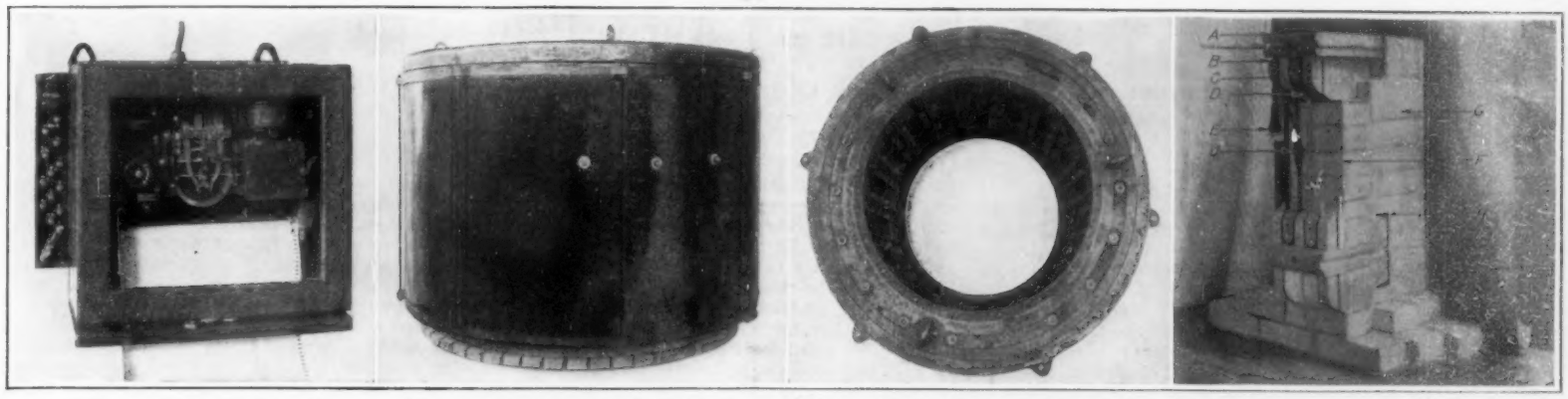


Temperature recorder controller for controlling temperature at two points in an oven or furnace

One complete section of a shrinking furnace used in the manufacture of big gun barrels

Interior view of a section of the shrinking furnace, with an inside diameter of four feet

Part of the inside wall of the shrinking furnace, showing construction of walls and refractories conveying heat ribbons

Recorder controller and section of a shrinking furnace, showing the constructional details referred to in the text

Electricity's Latest Contribution to the Modern Art of Heat Treatment

By A. M. Clark

DEMANDS made by the United States Government during the war period for the speeding up of ordnance manufacture caused remarkable improvements in electrical furnaces, which it is predicted will have a far-reaching influence on the commercial use of industrial heating in the future. Both the Army and Navy Departments, faced with the necessity of manufacturing guns in great quantity and at short notice, turned to the electrical engineer to help them solve their problems.

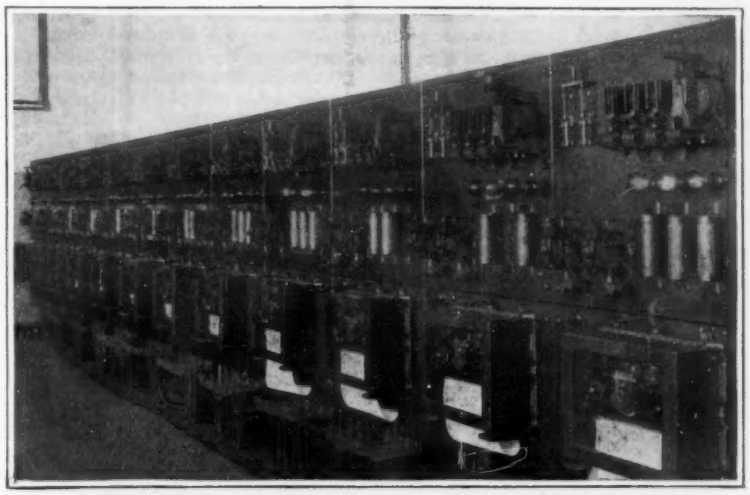
The result of all this has been the development, by a leading electric manufacturer, of a new type of electrical resistance furnace used with success in heat treating gun forgings and in shrinking the jackets on gun barrels of large caliber.

Two forms of furnace were developed—a high temperature resistance furnace creating a temperature of 1800° F. used in tempering, hardening, and gun forgings; and a low temperature furnace up to 950° F. used primarily for shrinking jackets over gun barrels and applicable to other practices, including shrinking collars on crank shafts, rims on wheels, etc.

This type of shrinking furnace is constructed in sections and has been built up to a depth of 88 feet. The best example is installed in the Washington Navy Yard, where guns of large caliber were built during the war. The furnace is of the vertical cylindrical type sunk into the ground to the required depth, a section of which is shown in one of the accompanying illustrations.

Its internal construction is shown in another view. Furnaces consisting of more than one section are usually equipped with a hand control which permits bringing the charge up to temperature at a uniform rate throughout the length of the furnace, the maximum temperature used being approximately 950° F.

When a one-section furnace is used, it is ordinarily provided with automatic control. Furnaces of more than one section are usually hand controlled, but automatic control can be provided.



Automatic panels and control instruments for large furnaces for heat treating gun forgings

Charging a deep electric heating furnace, which measures 22 feet deep and 6 feet in diameter

A complete one-section furnace consists of a cylindrical member, cover, base and work base. The cylindrical member comprises top and bottom castings with supports, inner and outer casings enclosing the insulating material, and heating units and guards. The cast rings which form the ends of the section are recessed in such a manner that the sections can be stacked one above the other, which permits constructing a furnace of any desired height from standard sections. Provision is made for the unequal expansion of the inner and outer casings due to difference in temperatures. There is a minimum of through metal from the inner casing to the outer casing, hence the heat losses are reduced to the lowest terms.

The heating unit consists of a resistance ribbon mounted on a cast iron supporting plate, and insulated therefrom by suitable refractory material. A number

(Continued on page 352)

How Colloidal Chemistry Aids the Paving Industry

By Daniel T. Pierce

COLLOIDAL chemistry is responsible for one of the most important developments the paving industry has seen since the first asphalt pavement was laid in 1876.

From that date to the present time something like 200,000,000 square yards of natural asphalt pavement have been built, to which must be added a smaller amount of manufactured or oil asphalt pavements. This enormous industry on which the comfort, cleanliness and health of city dwellers so largely depend, was built up very largely along empirical lines. The formulation of asphalt mixtures did not even approach standardization until Clifford Richardson's "The Modern Asphalt Pavement" was published in 1905. What were supposed to be ideal gradings of the sands forming the larger part of an asphalt mixture were arrived at by analyzing successful pavements and approximating as nearly as possible those gradings that had produced durable pavements.

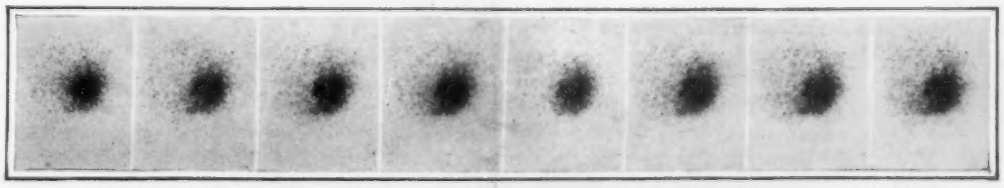
Emphasis has always been laid upon the importance of very fine particles in the grading of the mineral aggregate, for these are necessary to enable the mixture to "carry" a sufficient amount of bitumen to cement the pavement together and yet not to "bleed" nor make the pavement too soft. As an example of the sand gradings now accepted as standard may be instanced the specification in force in New York City, which calls for the following proportioning of the components of an asphalt paving mixture:

Mineral Aggregate	Per cent of Mixture
Passing 10-mesh sieve	10 to 30
Passing 40-mesh sieve	20 to 55
Passing 80-mesh sieve	13 to 30
Passing 200-mesh sieve	13 to 20
Asphalt	10 to 12.5

It may seem to the layman that the amount of mineral matter here required which will pass a screen having 200 meshes to the square inch would satisfy every reasonable requirement as to the presence of fine material in the mixture. But now with the aid of colloidal chemistry we have gone far beyond the realm of visible particles—that is, particles visible to the eye.

The starting point of this journey was a lecture on colloids delivered by Wolfgang Ostwald at the Laboratory of the College of the City of New York, March 20, 1914. This lecture happened to be attended by Clifford Richardson, who has specialized in the chemistry of bitumens for more than a quarter of a century. Dr. Ostwald showed that solids may be reduced to a state

(Continued on page 352)



On this strip of film the ultra-microscope has collaborated with the motion-picture camera in showing the Brownian movement of the particles in a colloidal mass

The Heavens in April, 1920

The Monumental Work of the Lick Observatory in the Study of the Nebulae

By Professor Henry Norris Russell, Ph.D.

MOST of the news of the heavens comes to the astronomer in short papers in scientific periodicals; but now and then he has a whole book to read at once. Within the last few weeks we have been fortunate in receiving a fine volume from the Lick Observatory, representing work which was practically completed before the war, but has been delayed in publication until now. Its nearly three hundred pages of text, and fifty photographic illustrations, deal entirely with studies of the nebulae, made at the observatory on Mount Hamilton and its southern branch in Santiago, Chile. Most of the researches which are here detailed have been described in shorter fashion previously; but the full evidence, now made available, is deeply impressive.

The book begins with a paper by Professor H. D. Curtis, containing descriptions of 762 nebulae and star-clusters photographed with the 36-inch Crossley reflector. Two-thirds of these are recognizably of spiral form—emphasizing again the great preponderance of this type among the nebulae. Indeed, if a special effort had not been made to study the nebulae of certain other forms, the proportion of spirals in the last would have been even greater yet.

A Census of the Nebulae

In addition to these large and conspicuous nebulae, which had previously been discovered and were picked out as good objects to photograph, small faint nebulae were found on the plates in enormous numbers. In an extraordinary region, in the constellation Coma Berenices, 304 of these small nebulae were found on a single plate, clustered so closely that fully a hundred of them were included in a region of the sky apparently no larger than the moon. Though such a cluster of nebulae is of course exceptional, the whole number of small nebulae, previously unknown and uncatalogued, found by Dr. Curtis on his plates is 5,698. And the entire area covered by these hundreds of photographic fields is less than one per cent of that of the whole sky. Taking account of the fact that relatively very few of these small nebulae are found in the region of the Milky Way, Curtis estimates that the number of them in the whole sky which could be photographed with a powerful instrument is about 722,000,000. That the totality of these small nebulae must be very great was first pointed out by Keeler—the former Director of the Lick Observatory—in 1900, and estimates by several astronomers since his time have given numbers ranging from 120,000 to 1,000,000. The present estimate is however doubtless the most reliable.

There is good reason to believe that most of these small nebulae are spirals. If they owe their apparent size to great distance rather than to actually lesser dimensions, they must be exceedingly far away; but it is too early in the study of these difficult objects to risk such speculation about them as a definite guess of distance.

The second paper by Dr. Curtis presents a superb array of photographs of spiral nebulae—mostly those that are turned edgewise toward us, or nearly so. He marshals very convincing evidence that in the outer regions of these nebulae there occur dark nebulosities—streaks and clouds of opaque matter, which hide the luminous material behind, and appear in the form of narrow dark streaks or lanes, often remarkably well defined. No argument is really necessary to prove his point other than the reproduction of the photographs: they show the effect beyond question. Whether these dark clouds on the outskirts of the spiral nebulae are similar in nature to those other dark clouds which Professor Barnard has found on so many of his photographs of the Milky Way, we cannot yet be sure; but the two phenomena seem to be very closely related.

Still a third paper by Dr. Curtis follows on the planetary nebulae—those remarkable bodies which appear telescopically as roundish or oval in shape, and with sharply depressed edges, and hence look something like a planet's disk. Photography shows that most of them have "central stars" or nuclei, and that the outer nebulosity is brighter at the edge than near the middle. Many of them have outer appendages on each side, resembling roughly the rings of Saturn. Some are large objects, several minutes of arc in diameter; others so small that they can be distinguished from faint stars only with the most powerful of telescopes. They show a strong tendency to congregate on the Milky Way—the smaller ones especially lying close to its central line. This indicates that they are not really smaller, but only look so because they are very distant, and that at such distances, except in the direction of the Milky Way, we come to the outlying vacant regions where both stars and nebulae are rare—or, at least, nebulae of this kind.

The brightening of these nebulae toward the edge, which is sometimes so conspicuous that they appear at first glance as luminous rings, is rather hard to explain; for if they are really ring-shaped, some of them would be seen edgewise and appear almost linear, while no such forms have ever been observed. Since the luminous material is known to be gaseous, it is doubtless transparent. If the nebula is really spherical or spheroidal, and most of the light is given out near its surface, it is easy to see that it will look brightest at the boundary, where this thin luminous stratum is turned edgewise toward us, and the light comes from a greater thickness of it. Dr. Curtis shows that by assuming this thin luminous shell of gas to be not of uniform thickness, but to be brighter near the poles in some nebulae and near the equator in others, the observed forms of most of the nebulae can be accounted for.

Unlike the spiral nebulae, the planetaries are very rare. Fewer than 150 are known in the entire sky, and since they are very easy to pick up by means of their spectra, our lists are probably complete.

Nebular Velocities

The next article, by Professor Campbell and Dr. Moore, deals with spectroscopic measurements of the motions of gaseous nebulae in the line of sight. Since the light of these objects is concentrated almost entirely in a few bright lines, it is possible to photograph their spectra, even though they be very faint—though the exposures that are necessary run up to heroic lengths, sometimes twenty or thirty hours, on successive clear nights. From these spectrograms the velocities of approach or recession may be determined, and the results are of great interest and importance. For example, it is found that the gases which shine in the Great Nebula of Orion are in turbulent motion. After allowing for the effects of the sun's motion in space, it appears that the nebula as a whole is almost at rest, but that different parts of it are coming toward us or receding from us at speeds which run up to seven or eight kilometers per second in either direction. There is a tendency for neighboring parts of the nebula to move at about the same rate, but no evidence of rotation of the mass as a whole. Huge as the nebula is—more than two light-years long and wide, according to Kapteyn's estimate of its distance—a body moving across it at the average rate at which the luminous gases are now traveling would pass clear through it from one side to the other in about 200,000 years. Since it is probable that this great nebula, like the stars, has lasted for millions of years, it seems likely that the observed motions represent some sort of turbulent circulation of matter within it; but what may be the nature and laws of this motion must be left to future investigation.

The planetary nebulae also show internal motions. In most cases these are interpretable as the result of rotation, and the whole nebula appears to be turning about the shorter axis of its elliptical outline, as might be expected. The rates of motion are often considerable—from five to ten kilometers per second. It follows that the total masses of the nebulae must be very considerable to provide a gravitational attraction sufficient to keep the outlying matter from flying off into space. For two nebulae whose parallaxes have been measured, the masses come out at least eight and eighteen times that of the sun, and very likely more.

In some cases the internal motions in the nebulae appear to be much more complicated, and cannot be explained by simple rotation. Most of these cases occur in nebulae of irregular form.

Besides these internal motions, the planetary nebulae are moving bodily in space with high velocities. After allowing for the effects of the sun's motion, Campbell finds that the average velocity of approach or recession for 102 such nebulae is 37 kilometers per second. This is more than twice the average speed of the stars of any of the principal types; and this fact, combined with the large masses and very small numbers of the planetary nebulae, makes it very improbable that they represent an early stage, or, indeed, any stage at all, in the evolution of ordinary stars.

The Ends of the Universe

One group of nebulae, however, had to be excluded from this discussion. There are nineteen gaseous nebulae in the Greater Magellanic Cloud—that agglomeration of faint stars, clusters and nebulae which is one of the most remarkable features of the southern heavens. Seventeen of these were observed at the Lick Observatory station at Santiago by Dr. R. E. Wilson. They are faint, and the exposures had to be very long, sometimes extending to eighteen or twenty hours. The results rewarded this labor, for all these nebulae showed enormous velocities of recession, ranging from 250 to 300 kilometers per second, but differing from the mean, 276 kilometers per second, by amounts much smaller than the relative motions of the nebulae in other parts of the sky. It is practically certain that these nebulae are really in the star-cloud, and that the whole vast assemblage of stars, clusters and nebulae is receding from us at this great speed. This confirms the conception that this cloud is an isolated outlier of our universe of stars, of independent motion and perhaps of separate origin.

There is but one gaseous nebula in the Smaller Magellanic Cloud, and this too has a high velocity of

(Continued on page 352)

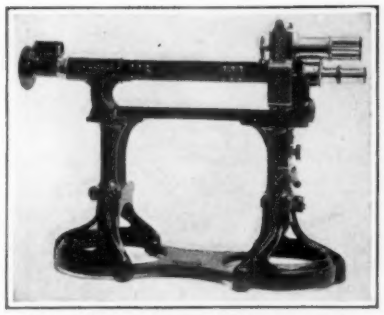
At 11 o'clock: Apr. 7.
At 10½ o'clock: Apr. 14.
At 10 o'clock: Apr. 22.

At 9 o'clock: May 7.
At 8½ o'clock: May 15.
At 8 o'clock: May 23.

At 9½ o'clock: April 30.

The hours given are in Eastern Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on April 7, etc.

NIGHT SKY: APRIL AND MAY



The adjustable saccharimeter used for testing sugars

Better Sugar Testing

MADE-IN-GERMANY standards are being constantly revised. Buying and selling of sugars has for many years been gaged according to the so-termed 100-degree point of the saccharimeter scale, which standard was formulated at the Sugar Institute in Berlin. Now the sugar-selling-and-buying instrument has been Americanized.

Moreover, the scientific discovery of an error of one-tenth of one per cent in the accepted standard by the Polarimetry Section of the Bureau of Standards will result in an annual estimated saving to Uncle Sam of $70,000 in revenue.

Seeking the cause of certain anomalies in the testing of sugars, the Bureau of Standards conducted a searching investigation of the degree point, the tests reflecting the error. The nature of the discrepancy was such that all sugars tested one-tenth of one per cent beneath actual value. The saccharimeter is the device employed in the standardization of the exchange of sugars, this precision measurement determining the 100-degree point by using chemically pure sugar.—By *S. R. Winters.*

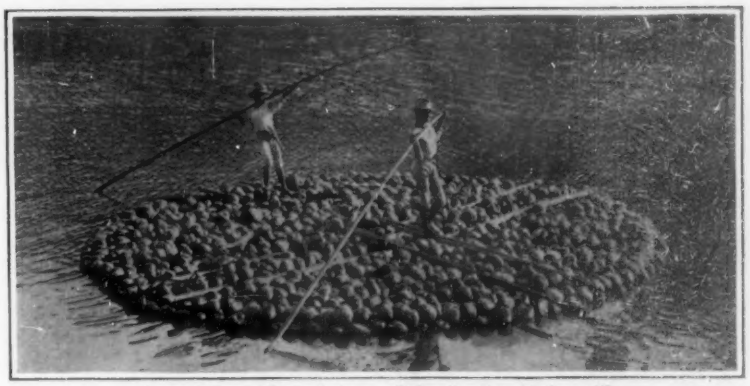
Moving a 500-Foot Viaduct

PREPARATIONS for the new Union Station Terminals in Chicago call for a tremendous amount of work. One of these important operations has been the moving of the Harrison Street viaduct. This ponderous structure, more than 500 feet in length, with its three truss spans each 146 feet long and its plate girder span 78 feet long, had to be moved bodily 18 feet to the north and raised 2 feet. Weeks of preliminary work were required before the real operation could be performed. For one thing it was necessary for very substantial bents to be constructed on which the bridge was to rest when in its new position. These were made of 12-inch square timbers solidly framed and bolted together. Four cross pieces were placed on top of these, supporting in turn a layer of 12-inch timbers securely bolted together. In some instances cribbing was built to furnish additional support for the bridge, the cribbing being supported by 14-inch I-beams. In addition, many precautions were taken to secure rigidity while the bridge was on its journey. Thus it was thoroughly braced by the use of 24-inch steel I-beams extending from one span to another. Above these I-beams were angle-beam plates to bear the load that might be imposed when the bridge was moved. Furthermore, stout timbers were used for posts wherever additional strength and rigidity were required. Between the bracings heavy timbers were placed crosswise to counteract the thrust of the jacks when they were called into play.

After all the fastenings of the bridge had been loosened, the bridge was jacked up two feet till the height conformed to the level of the new bridge and was in line with the bents. Then old rails were placed under each end to serve as skids. On top of these rails were placed smooth hardwood timbers, bolted together, and between the rails and the hardwood timbers came 2-inch solid steel castings on which the bridge was moved. Then unusually large jacks were set and braced. When the screws were all in place and everything was in readiness, the workmen applied the screws and the bridge slowly began its movement northward. Within less than twelve hours the bridge had reached its new position, being none the worse apparently for the trip. Here it will remain in daily service until the south half of the new viaduct has been completed, whereupon it will be torn down to make room for the north half.

Coincident with the moving of the bridge went on the work of digging the caissons for the new bridge. These were sunk to 60 feet below city datum, with the exception of one which was sunk down to rock. These caissons were 4 feet 6 inches in diameter, the concrete extending up to 12 or 14 feet below city datum. Girders 10 feet deep, 5 feet 6 inches wide, and 48 feet long, were each reinforced with 8 tons of steel and placed over the caissons. They will support the columns on which the new viaduct will rest.—By *George F. Paul.*

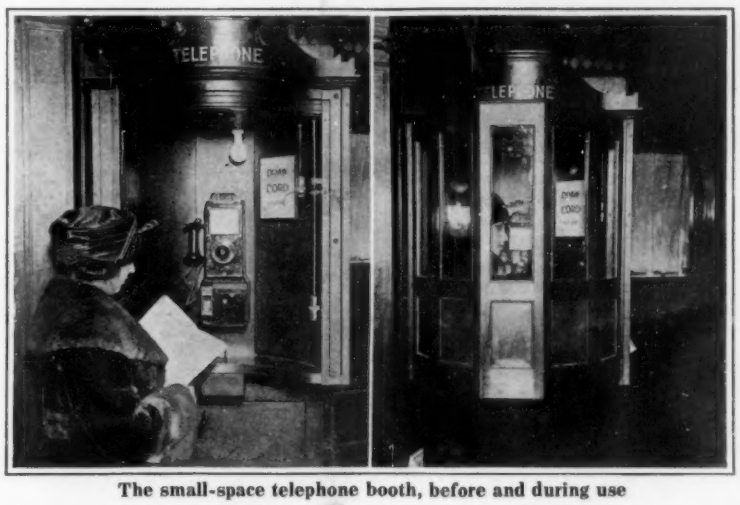
The viaduct that was raised two feet and shifted six yards to one side



Cocoanuts made up into a raft for floating to the mill

The Cocoanut Raft

IT is well understood that in the tropics the cocoanut occupies much the position which the reindeer holds among the Eskimos. It means food, drink, shelter, fuel, utensils, textile fiber. It is the universal thing to which the native turns in all emergencies. But even knowing this, it is a little startling to see this nut of general utility employed as a means of transportation. Nevertheless, it is so employed, as our photograph, taken on one of the picturesque streams of the Philippines, testifies.



The small-space telephone booth, before and during use

The Half-Length 'Phone Booth

THE conventional telephone booth takes up a vast deal of space, and is not especially convenient or comfortable. One of the New England companies has been experimenting in the effort to devise a better booth, and the photograph shows the result. The new booth is built to hang from the wall or to stand on a pedestal. In width it is 30 inches; it projects from the wall only 16 inches when not in use, and 30 inches when occupied. In this way its maximum demand for space is made only while it is being used, and not perpetually, as with the older style of booth. It "covers" the user down to the waist only; but in spite of this it keeps out outside noises very satisfactorily. It is closed for use by drawing a cord which revolves the circular glass-panelled frame into position around the user. This frame runs on a ball-bearing overhead track.

A Non-Shattering Glass

THE stimulus to human ingenuity incident to the great war produced an amazing array of striking inventions and discoveries. Of these it may safely be said that the greater number, because of their highly specialized nature, have already lapsed into disuse, having served their purpose. Few can claim adaptability to the arts of peace.

In this latter category we find a new triplex safety glass—a character of glass that resists shock. By a process of placing a thin sheet of xylonite between two sheets of glass, sandwich-wise, and causing them to adhere by a special process under heat and pressure, a panel of glass is produced in the finished article that is transparent, non-shatterable, soundproof, airtight, and watertight, even when badly cracked.

As evidence of the faculty of this glass for resisting projectiles an interesting test was recently carried out in the rifle range of the 69th Regiment Armory in New York City. A number of panels of the glass varying from ½ inch to one inch in thickness were set up, one at a time, in a frame and subjected to the fire of a .45 automatic pistol at ranges varying from one to fifteen feet. The effect of these shots was that at the point of impact the bullet penetrated only about 1/32 of an inch and was torn to shreds. On a few thinner panels under the same test some glass became detached from the reverse side. In the case of the thicker panels the reverse surface crumbled at the center of a star-like fracture and fell out in powdered form but did not fly.

Many an airman owes the preservation of his sight, and in the numerous cases of his life, to the use of this glass in his goggles and windshield. But it is in its application to the arts of peace that this unbreakable glass is destined to achieve its greatest triumphs, in the interests of humanity and public welfare. Safety goggles for workmen in steel mills and other industrial plants are now fitted with it to safeguard eyesight. It can be substituted for common glass in every instance where used for lighting purposes or for protection, that is, for windshields, windows, swing doors, panels and portholes; for showcases, for glazing valuable pictures; and other luminators in prisons, sanitariums and insane asylums. A startling feature is that it is burglar-proof. It cannot be cut with a diamond. It resists all but the most violent blows and is immune to the bank robber's gun.

The bullet was ruined, but not the glass

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

This little gasoline-driven saw fells 500 trees a day

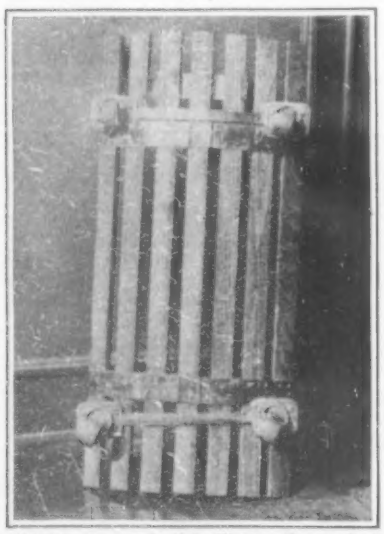
Again—The Gasoline Tree Saw

A GERMAN inventor is responsible for the latest gasoline tree saw, which forms the subject of the accompanying illustration. This machine consists of a small two-cylinder gasoline engine, a band saw held in a suitable frame, and a jointed driving shaft between engine and saw units. The entire outfit is said to be quite light, permitting of ready transportation. The saw will cut down over 500 trees of an average diameter of 12 inches, in one working day.

Auto Crawler

EVERY owner or chauffeur of an automobile dislikes to be compelled to lie upon the ground to fix some part of the mechanism of his car and, no matter how good the car or the price paid for it, there comes a time when this becomes necessary. Often it occurs upon a dirty, muddy road—the consequence, ruined clothes or a spoiled lap-robe.

The auto crawler has been designed to meet just such emergencies. It is a foldable, collapsible, wooden-slatted cradle, supported by four iron castors, with a detachable head rest at one end. A person lying full length upon the cradle may easily push himself along so that any part of the underside of the car will be within reach, and the repairing, cleaning, or oiling done. This device folds into a compact bundle and is carried under the seat, being always at hand ready to save the clothes from dirt, grease and mud. It is small, strong and light in weight.

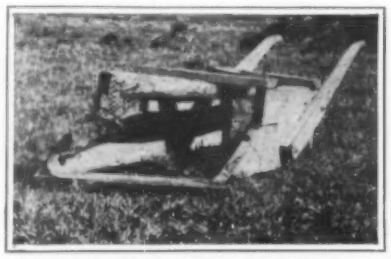


This "auto crawler" facilitates the work of the one who must get out and get under

A Rush Cutter for Drainage Operations

AS a preliminary to drainage operations, it is generally necessary to cut the swamp growth to facilitate the work to follow. For this operation the apparently crude device shown in the accompanying illustration has proved exceedingly efficient. It is a horse-drawn affair, with a sharp blade mounted close to the ground. The device is hauled along by one or two horses and slides over the marshy ground by virtue of its crude wooden runners. A pair of handles at the rear permits the device to be steered.

By changing the point at which the hitch is made to the cutter, the cutting blade can be raised or lowered so as to control the height of the cut. All in all, this device does its work well.



This rush cutter cuts down swamp growth preparatory to drainage

A Wind-Driven Cyclecar—and Sled

TRUE, there have been numerous air-driven automobiles and cyclecars described and illustrated in these columns in the years gone by; but the present air-driven vehicle is at least unique in the particular that it can be transformed into a sled at an instant's notice. The running boards of this diminutive car are in reality a pair of flat runners, which can be brought into play by a simple mechanical movement. As a three-wheeled vehicle, this machine, driven by the twin-cylinder V-engine and four-foot propeller, attains speeds of from 40 to 60 miles per hour.

German Process for Artificial Wool

ACCORDING to *L'Exportateur Belge*, there is considerable interest in Germany in a patent recently taken out on a process for the manufacture of artificial wool.

In principle, the process consists of compressing wool scraps which cannot be otherwise utilized—shreds, ends, short fibers, washing wastes, etc.—and soaking them in a viscous solution of cellulose or one of its compounds with a small percentage of glue; the product thus obtained is cut into thin sheets and strips, which can be treated after the manner of paper yarn. The Germans claim that the yarn thus obtained possesses all the properties of real wool. It is made waterproof by treating it in the process of manufacture with compounds of chromium and later with formaldehyde and tannin, after which the product will resist the action of boiling water. The addition of glycerine gives it sufficient flexibility.

This process is now being modified by the mixture with the woolen waste of a certain percentage of paper pulp and treating the product with sulphuric acid and zinc chloride. The addition of various other compounds gives it the necessary flexibility.

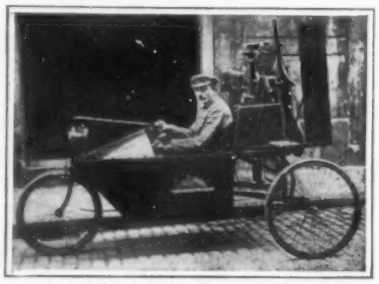
Portable Drafting Kit for Field Engineers

THE field engineer in many lines of work has heretofore been greatly hampered in his drafting work by the lack of a kit which could be easily moved from point to point and one in which he could carry all the paraphernalia such as T-square, instruments, slide rule, bottles of ink, etc. Because this need has existed, a Milwaukee engineer has recently devised a kit to meet these very conditions. The outfit is shown in the accompanying illustrations.

It consists first of a neat leather-covered case which folds up much like the ordinary suitcase. This is just large enough to hold an 18 by 24-inch drafting board which is placed on top of the lower half of the case when open. Below the board may be carried several handbooks, bottles of ink and the like. In the cover are two slip-in envelopes for triangles and set of instruments. Then there are two narrow leather straps made up with loops to hold a T-square, slide rule, eraser, pen, pencils and scale.

What Other Manufacturers Can Learn from the Germans

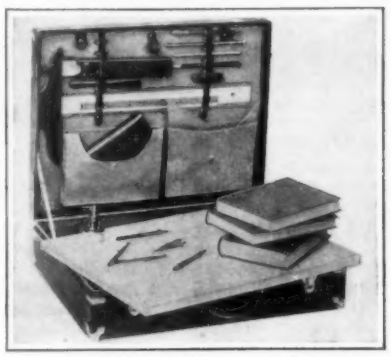
QUITE recently a commission of Sheffield Cutlery manufacturers visited Germany with the object of studying German cutlery works. While the official report of their observations has not yet appeared, some of the members of the party have pointed out the remarkable manner in which the German manufacturers handle their parts in bulk.



A combination cyclecar and sled invented by a German

A good many different patterns are produced, but always in much larger quantities of each than is the case in Sheffield, and great ingenuity appears to be shown in discovering ways of dealing with parts of cutlery in bulk. For instance, blades are rarely hardened singly; handling six or a dozen at once is the usual practice. For that purpose ingenious holding devices are used. The tempering is done in boxes which hold several gross of blades. Pocket-knife springs are placed in holders and glazed and polished two or three dozen at a time and handles are turned on lathes which deal with half a dozen at once. The German specializes very much upon scissors, and, by subdividing the work, produces an excellent article at a low figure. Compared with those paid in Sheffield at the time, the wages in Solingen before the war were in many cases distinctly low, but considerable advances have taken place.

The conclusion to which some of the Sheffield representatives came was that, as regards quality, they have not much to learn from the Germans, but that, if they are to reach them and keep up with them in the matter of output and prices, to a very great extent they shall have to copy the German methods. If they do so now, the British believe there is a great future for the Sheffield cutlery trade.



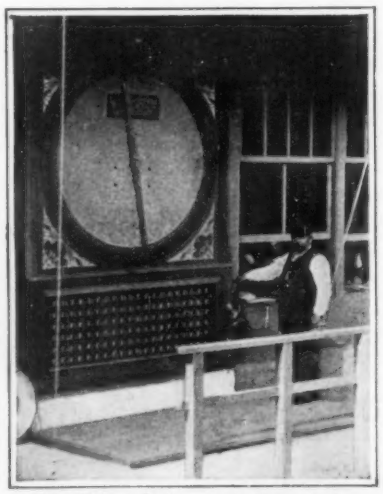
A complete kit of drawing implements, slide rule and reference books for the itinerant engineer

Auctioneering by Electricity

AN electrical method of conducting auctions has been adopted in Holland, due, in large measure, to the proverbial phlegmatic temperament of the Dutch people and their hatred of boisterous proceedings.

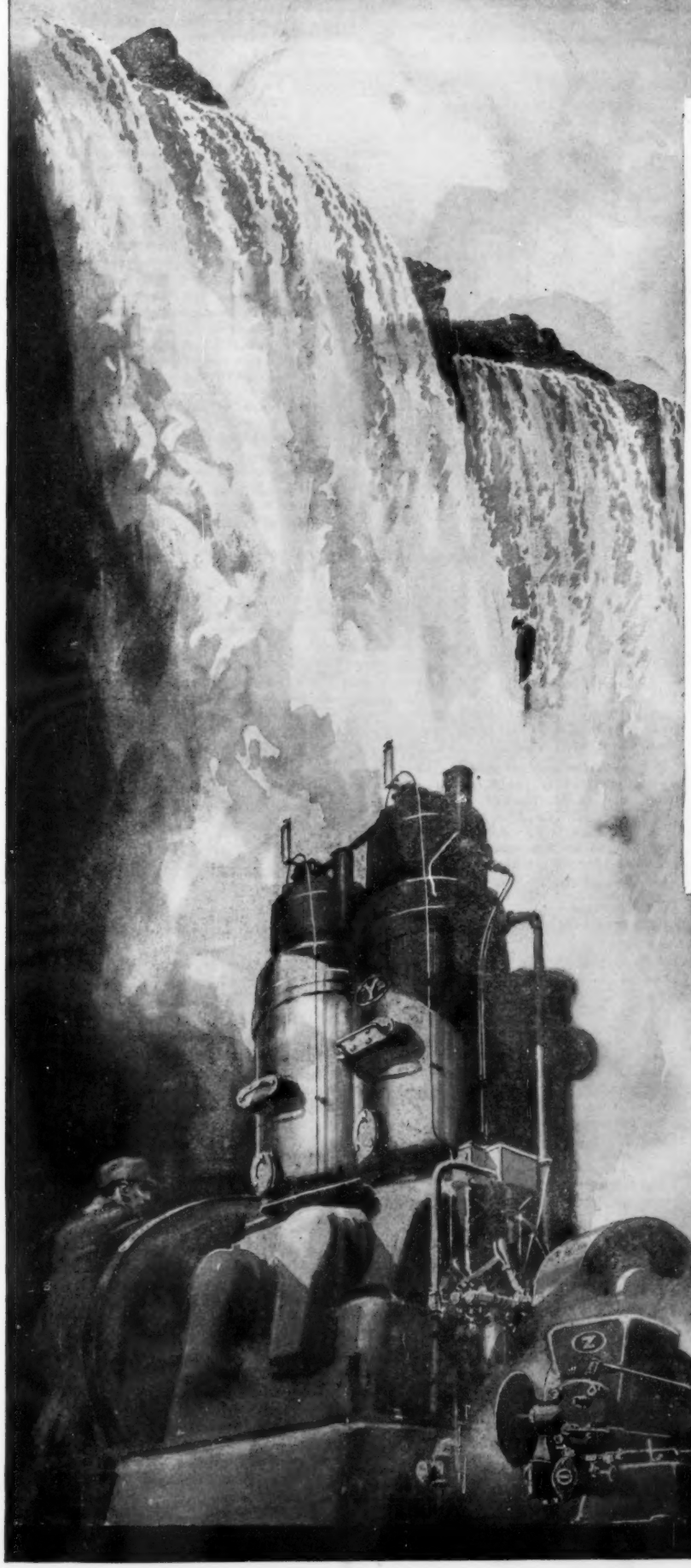
In this electrical auction, every bidder receives a number and must take the seat marked with that number. On the auctioneer's platform is an annunciator board, surmounted by a dial with a pointer indicating the prices of the sale. The annunciator board bears as many numbers on it as there are seats in the hall. Every number on the board is connected by proper wiring with the chair carrying the corresponding number. When the sale begins, the pointer is set in motion, and as soon as one of the prospective purchasers sees indicated a price which he is willing to pay, he presses a button on his chair, causing the pointer to stop and the number of the bidder to be automatically registered. A bell rings to indicate the bid.

It is reported that this system is working out very well in actual practice. The accompanying views show the Rotterdam Auction Hall, where vegetables are being auctioned off.



This dial and the annunciator below indicate the bidding at an auction

FAIRBANKS-MORSE



PRIME MOVERS IN INDUSTRIAL PROGRESS

FAIRBANKS-MORSE has done much to further the development of prime-movers that conserve both fuel and labor. It is logical that this should be so. For Fairbanks-Morse has pioneered in building these prime-movers. With this result: That on over a quarter of a million farms the Fairbanks-Morse "Z" Engine has released a million farm hands for more productive labor. In countless factories—in vast industrial power houses—in mines—on rice plantations—and in lighting plants and pumping stations, the giant Fairbanks-Morse "Y" Oil Engine turns the load of industry upon its ponderous crankshafts as easily as you would wind your watch. And on a thousand water fronts, from Singapore to San Diego the sturdy "C-O" Marine Oil Engine helps to carry the world's commerce in bottoms ranging from the humble tug and workboat to the huge four-masted auxiliary.

Truly, a veritable Niagara of power flows from the factories of Fairbanks-Morse! But not in volume of output alone does the house of Fairbanks-Morse lead every other in its field. For quality to us is even more important than volume production. This is the goal which is reflected in the Fairbanks-Morse Quality Seal—the mark of *industrial supremacy*—by which this house is known.

Our products include Fairbanks-Morse Scales—oil engines—pumps—electric motors and generators—railway appliances and coaling stations—farm power machinery, such as "Z" engines—lighting plants—water systems.

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Recently Patented Inventions

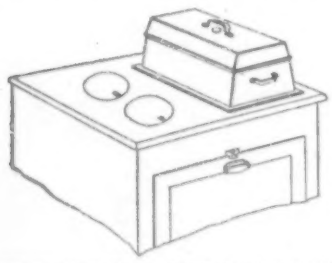
Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Of Interest to Farmers

SACK HOLDER.—A. L. RENFRO, R. F. D. No. 6, Box 76, Bakersfield, Cal. This invention has for its object to provide a device adapted for use with threshing and milling machines, for supporting the bag or sack into which the grain is discharged, in such a manner that the mouth of the bag will be held distended to receive the material without spilling, and wherein the bag will be uniformly filled without the necessity of tamping or shaking, and wherein the bag may be readily attached or detached.

Of General Interest

COOKING UTENSIL.—L. V. WINTER, Box 162 Juneau, Territory of Alaska. This invention relates more particularly to cooking utensils adapted to serve either as a broiler or a boiler. An important object is to provide a device in which the fumes and disagreeable

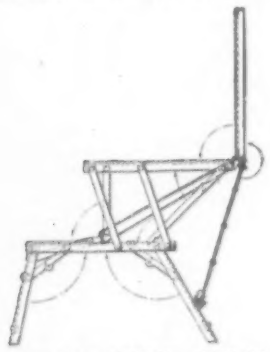


A PERSPECTIVE VIEW, SHOWING THE UTENSIL IN POSITION ON THE STOVE

odors resulting from the cooking of food are not allowed to escape into the room in which the cooking is being carried on but are conveyed back to the stove and are disposed of in the same manner as the gases of combustion in the stove.

ADJUSTABLE AND KNOCKDOWN WINDOW SEAT.—E. ANDERSON, 4912 4th Ave., Brooklyn N. Y. The object of the invention is to provide a window seat more especially designed for safely accommodating a person washing a window. Another object is to permit of conveniently adjusting the window seat to windows of different width and construction. Another object is to enable the user to readily attach or remove the seat, and to disassemble the parts and form the same into a small bundle for convenient shipping or storage.

FOLDING CHAIR.—J. L. CELANE, 131 Essex St., New York, N. Y. Among the objects of this invention is to provide a folding chair of simple and rugged construction which may be readily and conveniently folded to occu-



SIDE ELEVATION, SHOWING CHAIR IN OPEN POSITION

py but little space, whereby it could be used as a camp, beach or picnic chair. Further objects are to provide a construction that when opened two seats are formed, one of which may be occupied by an adult, the other by a child, and to be provided when open with a foot rest.

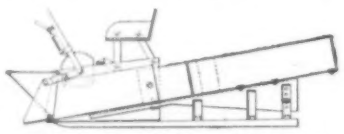
SAFETY-STRAP FOR BABIES.—A. M. DUNNING, address Mrs. F. H. Adams, 3066 Perry Ave., Bedford Park, Bronx, N. Y. The object of the invention is to provide a safety strap for babies arranged to permit a person to safely suspend a baby to allow the latter to walk without undue strain on their legs, or to securely hold the infant in a baby carriage or chair without danger of its falling out, at the same time allowing the baby considerable freedom of movement.

SLUG.—E. L. CUSHMAN, 602 Poinciana Ave., Miami, Fla. The invention relates to matrices for linotype or intertype and similar machines for preventing blurring or smutting of the sheet where several quad lines occur together. The edvice has projections raised above the general level of the face of the slug where printing characters are ommitted for the purpose specified, said projections being of less height than the printing characters.

LEVER FILLER FOR FOUNTAIN PENS.—DE WITT C. VAN VALER, address H. W. Geyer, 170 Broadway, New York, N. Y. As object of the invention is to provide a filler construction formed with a lever support positioned within the pen casing but not secured thereto, the support acting as a guide for the presser bar and as a support for the lever acting on the presser bar. A further object is to provide a filler structure having a support with a bar hinged thereto and the parts so arranged that the hinge will be within the wall of the pen casing.

SIGNAL AND GUIDE LIGHT.—H. H. DONER, 124 W. 43rd St., New York, N. Y. An object of the invention is to provide a construction which may be used with any form of lamp now in common use to present an illumination for the location of an object, or as a signal to indicate certain facts. A further object is the provision of a hood arranged with numbers or other configurations on the exterior and with a cone shaped central member for distributing the light from a lamp.

SNOWPLOW.—J. KORHONEN, Box 561, Englewood, N. J. The invention has for its object to provide a construction in which the snow may be discharged at a plurality of different points by a slight rearrangement of the rear part. Another object is to provide



A LONGITUDINAL VERTICAL SECTION OF THE INVENTION

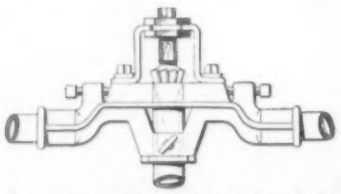
a snow plow in which substantially the full width of the plow acts to scoop up snow so that the plow structure may travel along over the surface which has been cleaned.

FASTENING DEVICE.—E. RENDANO, address Philip Forbes, 50 Columbia Heights, Brooklyn, N. Y. The object of the invention is to provide a fastening device more especially designed for quickly an dsecurely fastening plaster boards or wall boards to studding or other supports in buildings. To accomplish the result plates are provided with stuck-up prongs which pass into the wall board and aer bent into a clenching position, thus presenting no undesirable projections on the face of the wall board.

Hardware and Tools

ASH SIFTER.—T. J. MCIVOR, 49 Beaconsfield Ave., London, Ont., Canada. The general object of the invention is to provide a portable sifter arranged to receive bodily the ordinary ash pan of a furnace, range, or stove, and adapted to be turned through 180° to invert the ash pan and dump its contents into the sifter, the sifter being adapted to be rocked to effect the sifting, and arranged to be closed tightly against the escape of ashes.

TOOL HOLDER.—F. T. ALCOCK, 1695 Kingsway, So., Vancouver, B. C., Canada. The invention has for its object to provide a holder of the character specified, especially



A FRONT VIEW OF THE HOLDER IN PLACE ON STOCK AND DIE

adapted for connecting a pipe reamer to a set of stocks and dies, in such manner that the reamer will come into operation at the end of the cuttinng of the thread.

JACK BASE.—H. I. BENEDICT, 1705 3rd Ave., New Orleans, La. This invention relates to lifting jacks. A specific object is the provision of a jack in which the lifting element is capable of being easily and quickly set to any desired position with respect to the load, and then operated by a crank or equivalent means for lifting the load. Another object is the provision of a form of base and barrel adjustably mounted therein whereby the height of the jack can be varied within comparatively wide limits.

RATCHET BRACE.—E. ASCHE, R. F. D. No. 3, Clara City, Minn. The object of this invention is to provide a construction which may be used as a clamping brace or bracket

A SIDE VIEW OF THE DEVICE

and also as a drill brace. A further object is to provide a brace with an adjustable resting member adapted to face in a plurality of directions so as to coact with objects in different places in respect to the drill carried by the opposite end of the bracket.

Heating and Lighting

FURNACE.—H. BENTON, 657 Jefferson Ave., Elizabeth, N. J. The invention relates to furnaces of a type suitable for heating boilers and the like, and adapted to be fired by hand. The invention comprehends a furnace in which coal is used as a fuel, provision being made for giving the coal a preliminary heating, thus reducing it to coke before it is carried into the flames, the heating of the coal serving to drive off the volatile matter prseent so as to reduce it to gases, these gases being conducted into the flame.

Machines and Mechanical Devices

TYPEWRITING MACHINE.—N. KOUSNETZOFF and E. M. KOZMIN, 116 W. 39th St., New York, N. Y. The particular object of the invention is to provide typewriting machines that are composed of the least possible number of parts, that are practically noiseless, that have provision for an absolutely uniform stroke or impression, and that are small and relatively light in construction as well as being cheap to manufacture and reliable in practice.

MACHINE FOR MAKING COIL SPRINGS.—A. MCK. PARKER, Georgetown, S. C. The invention relates to machines for making coil springs, and has for its object to provide a simple, easily operated machine of the character specified by means of which springs of any desired diameter may be coiled, and with the coils at various distances apart.

EXHIBITING DEVICE.—S. PFLASTER, 205 E. 87th St., New York, N. Y. This invention has for its object the provision of a construction which is simple in the general make-up and easy of operation whereby pictures or other subjects are exhibited successively. Another object is to provide a machine which will automatically operate for bringing slides and negatives to a position for being projected on a screen at timed intervals.

MIXER.—L. M. BRAYMAN, R. F. D., Westville, N. H. An object of this invention is to provide a mixing machine which can be inexpensively manufactured, which can be constructed of different kinds of material and which is compact in form and light in weight. A further object is to provide a mixer in which dry materials, such as poultry food can be rapidly introduced, mixed and removed therefrom, the machine being hand or power-driven.

ROTARY PRINTING MACHINE. — C. WINKLER, Berne, Switzerland. The object of the invention is firstly, to permit both the front and back of the sheets, in a simpler manner than heretofore possible, with the assistance of a plate carrying cylinder of single width having only two plates on its circumference, and of an impression cylinder also of but single width.

DRIVING GEAR FOR PRINTING MACHINES.—C. WINKLER, Berne, Switerland. The invention relates to a driving gear for printing machines which is provided with two couplings or clutches adapted to be put in and out of operation for the printing speed and for a slow movement, and are so connected with each other that in one extreme position the machine is driven at the printing speed, in the other extreme position, at a slow speed, and in the middle position the machine is braked and stopped.

SHAFT CLAMP.—F. J. POND, Sherman, Texas. The invention relates to shaft clamps, and has for its object to provide a clamp especially adapted for clamping wheels or reels to shafts, to constrain the wheels to rotate with the shaft, wherein the engagement is such that there is no possibility of the wheel slipping with respect to the shaft.

SHUTTER-ADJUSTING DEVICE.—L. C. PAGENHARDT, Box 527, Westernport, Md. This invention relates more particularly to motion picture machine mechanism for adjusting the revolving shutter. One of the objects is to provide a shutter, means being embodied for enabling cetrain adjustments while in motion, thereby eliminating a commonly known defect called "travel ghost," without interfering with the operation of the machine. A further object is to provide an adjusting device which is easily applied.

PROCESS AND APPARATUS FOR ORE SEPARATION.—J. D. ROSS, c/o Lightig Depot, Seattle, Wash. The invention has for its general objects to simplify the methods of separating finely ground ore. The process consists in precipitating downwardly in an oblique path a continuous stream of ore, subjecting such continuous stream to successive jets of mixed air and water directed angularly into the ore pulp during the progress through such oblique path, and in removing portions of the ore by flotation at intervals between the successive jets of mixed air and water.

BOOK-COVER-MAKING MACHINE.—J. SATENSTEIN, c/o Am. Book Bindery, 406 W. 31st St., New York, N. Y. Among the principal objects of the invention are to adapt a machine of the character mentioned for using a filler more pliable than that usually employed, to adapt a machine for making soft or flexible covers for books, to simplify the construction, and to provide for readily replacing the parts.

Medical Devices

HYPODERMIC SYRINGE.—R. H. RIETHMULLER, address Herman A. Metz, 122 Hudson St., New York, N. Y. The object of the invention is to provide a hypodermic syringe whereby the use of a graduated glass barrel is dispensed with and a non-graduated barrel can be readily removed from the casing, in case it is broken or injured, to permit of replacing it by a new one, or to permit of readily sterilizing the casing and its glass barrel.

Musical Devices

AUTOMATIC STOP FOR PHONOGRAPHS.—G. H. TAGGART, c/o Baxter Estate, Port Washington, L. I., N. Y. This invention relates to automatic stops for phonographs of the type covered by patent No. 1,284,833 issued to the same inventor Dec. 3, 1918, the purpose of both inventions being to provide a tripping mechanism for the brake whereby the brake will automatically open the turntable, stopping the rotation thereof at the moment the stylus reaches the inner end of the record groove.

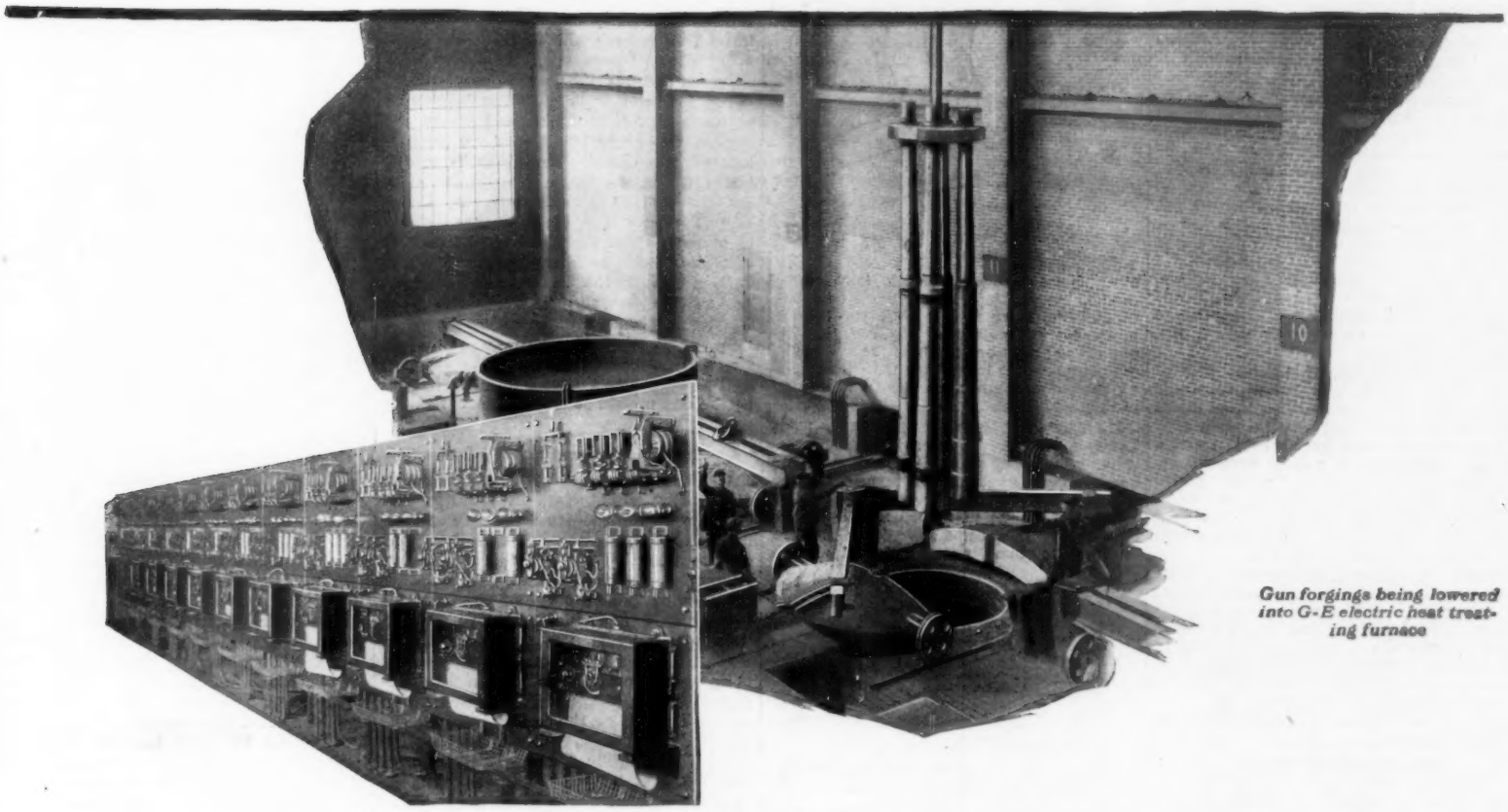
TALKING MACHINE.—A. D. ANDERSON, c/o De Rivas & Harris, 138 Willow Ave., Bronx, N. Y. The invention relates more particularly to that type of machine which is combined with an article of furniture, as, for example, a table. The prime object is to so construct the device that the operation of placing and removing the record tablets is greatly facilitated and that a tight and continuous passage is obtained between the amplifier and the tone arm.

Prime Movers and Their Accessories

CARBURETER.—G. MEZZATESTA, 101 W. 58th St., New York, N. Y. This invention has for an object the provision of a construction wherein the usual float now in common use has been eliminated while means have been provided which will supply the proper amount

(*Continued on page 344*)

Unquestionable performance in widely different industries has made electric heating just as vital a necessity as electric power and light



Gun forgings being lowered into G-E electric heat treating furnace

Melting Wax and Shrinking Mighty Guns with the Same Heat

It is a far cry from the waxed thread that holds the sole on a shoe, to the 16-inch guns that boom out a warning to the world to beware of Uncle Sam's Navy. Yet the same form of heat, electric heat, that melts the wax on the thread as it passes through the stitching machine of the shoe factory, is used to shrink jackets on the monstrous rifles which are truly termed the "teeth of the Navy."

Cartridge type electric unit for localized heating

In one case, the miniature cartridge type of heating unit is employed. In the other, a huge electric heat-treating furnace, which supplies the exact amount of heat required at any given time, proved itself invaluable in war time and has since demonstrated the superiority of electric heat for the demands of peace time industry.

Ranging in size from 42 inches to 7 feet in diameter, and from 6 feet to 90 feet in depth, G-E furnaces are wonderfully efficient and surprisingly simple. The operator, sitting comfortably at his desk with voltmeter, heat measuring instruments, switches, etc., controls at his finger tips the temperature wanted, regulated to the finest degree, for a short or long period of time, in any part of the furnace.

Such absolute control is as much a part of G-E electric heating equipment as the apparatus itself. And behind this is the broad experience and wide-spread activity of the General Electric Company, which is available whether the problem is simple or complex.

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RECENTLY PATENTED INVENTIONS

(Continued from page 342)

of gasoline or fuel as needed. A further object is the provision of a carbureter especially adapted for use on airplanes, and arranged with means whereby the carbureter will supply fuel from the supply tank whether the same is above or below the carbureter.

IGNITION PLUG FOR INTERNAL COMBUSTION ENGINES.—L. LAVOISIER, Paris, France. This invention has for its object to provide an ignition plug which differs essentially from ordinary plugs by its central rod or electrode, being bored and provided with apertures in such a way as to allow the surrounding air entering it up to its inner end. This arrangement provides for effective cooling, thus resulting in extending the duration of it suse, and increasing the security of working.

Railways and Their Accessories

RAILWAY SWITCH HEATER. — W. T. LAWLOR, 68 Wayne St., Jersey City N. J. This invention has particular reftrence to devices, the general character of which is set forth in Patent No. 1,281,797, issued to the same inventor October 15, 1918. An object of the present improvement is to provide a pan or receptacle for holding a quantity of fuel such as oil between adjacent ties and beneath the switch rails, the receptacle being so constructed that the oil may be sent thereto and retained therein in burning condition and even in small quantities while a train may be running over the track.

RAILWAY LINK.—L. W. EISINGER, 52 Vanderbilt Ave., New York, N. Y. The object of the invention is to provide connecting means by which passengers may be transferred from a local or express train on one main line to a local or express train on another main railway line. Each of the two main lines have double tracks, and additional tracks from the tracks on one of the main lines which cross each other, one over the other, which connect with the tracks on the other main line.

STEEL TRACK.—S. B. DICKINSON, Bath, N. Y. This invention relates particularly to an all steel track and foundation, and has for its object the provision of an arrangement whereby a continuous support may be provided for supporting a metal track carrying rails of the usual type. Another object is to provide a more or less resilient foundation formed in the nature of spaced supporting columns or piers.

Pertaining to Recreation

TOY.—P. M. CONDON, 156 Colonia St., Albany, N. Y. The object is to provide a toy in the form of a wheeled vehicle having a seat for an occupant and having means for tossing a ball from the front of the vehicle to the occupant in the seat, and for guiding the ball back to the front of the vehicle, said tossing means being spring-controlled and movable into position to toss the ball by the occupant of the seat.

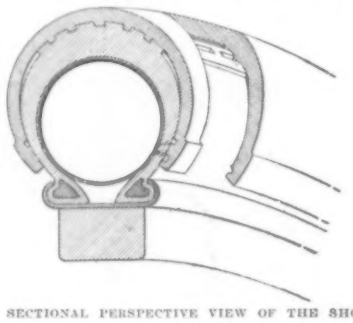
Pertaining to Vehicles

VENTILATOR FOR AUTOMOBILE TIRES. —T. C. MCEWEN, Caldwell, N. J. The particular object of this invention is to provide a ventilator so constructed as to allow of the inhaling and exhaling of a constant supply of fresh air between the inner tube and the lips of the tire for the purpose of reducing to a minimum the number of blow-outs, as well as

SECTIONAL VIEW SHOWING A TIRE WITH THE VENTILATOR ATTACHED

the deterioration of the tube and tire due to the fact that the air has become stagnated and foul by having no means of escape. A further object is to provide a ventilator as shown in the accompanying cut, having a screen-covered opening, the latter for the purpose of preventing dust and other extraneous matter from coming in contact with the inner tube, but permitting a constant supply of fresh air to reach the tube. The foul air is exhaled and the fresh air inhaled while the car is in motion due to the fact that as the tire passes over the surface of the road a pumping action results.

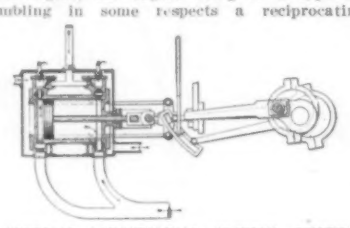
OVERSHOE FOR TIRES.—B. J. MULLIKIN, 253 W. 72nd St., New York, N. Y. The invention relates to tires having a casing enclosing an inflatable tube. The object is to provide an overshoe to prevent the casing being subjected to undue wear, and to reduce the danger of puncture of the inner tube to



A SECTIONAL PERSPECTIVE VIEW OF THE SHOE AS APPLIED

a minimum. Another object is to permit of making the overshoe of an inexpensive material. The inner face opposite the tread is provided with projections and engaging corresponding recesses to hold the overshoe against movement longitudinally or transversely. The shoe when worn can be readily replaced.

EXTERNAL EXPLOSION ENGINE.—W. E. LAWN, 61 Beacon St., Rochester N. Y. This invention has particular reference to automatic power-driven machines such as vehicles. Among the objects is to provide a type of automobile or similar machine, which carries its own engine, the engine being of a type resembling in some respects a reciprocating



A VERTICAL LONGITUDINAL SECTION, SHOWING ENGINE AND REVERSING MECHANISM

steam engine, but obtaining its driving force from the explosion or burning of liquid fuel. The invention aims to provide an engine to eliminate the self-starter, carbureter, water jacket and water pump, radiator, cooling fan, and different speed gears; one cylinder producing the same amount of energy of four of the present design of internal enginnes.

RESILIENT TIRE CUSHION.—E. MCDOWELL, 450 Peachtree St., Atlanta, Ga. The invention relates generally to automobile tires, and more particularly to a resilient cushion for use therein in lieu of the usual inner tube, and corresponding to air pressure, the object being the provision of a cushion, the structure of which will permit of the utilization of waste rubber, especially used inner tubes.

AUTOMOBILE LAMP.—W. A. IRWIN and L. F. JACKSON, address W. A. Irwin, 1482 Broadway, New York, N. Y. Among the objects of the invention is to provide a lamp designed for the purpose of throwing ample light on the roadway ahead without any possibility of glare. Another object is to provide a lamp casing having means for diffusing the light upward and laterally in all directions so as to illuminate the roadway at the sides of the vehicle as well as surrounding objects.

We wish to call attention to the fact that we are in a position to render competent services in every branch of patent or trade-mark work. Our staff is composed of mechanical, electrical and chemical experts, thoroughly trained to prepare and prosecute all patent applications, irrespective of the complex nature of the subject-matter involved, or of the specialized, technical or scientific knowledge required therefor.

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The Panama Canal Today

(Continued from page 330)

motives, two or three on each side, according to the size of the vessel. The ship is not allowed to use its own power, but is towed into the locks and taken from lock to lock by the electric towing locomotives. On emerging from the upper lock, the ship passes into Gatun Lake and proceeds under its own power at speeds of from ten to fifteen knots, according to the depth of the channel which is being dredged in the bottom of the Lake. The ship steams through the Lake for 24 miles until it reaches the Continental Divide above referred to. Here the hills begin to close in on the channel, and for the next eight miles or so, it passes through a deep cut through the mountains. Here the channel is 300 feet wide at water level, and at one point, Gold Hill, the sides of the cutting rise about 500 feet above the bottom of the Canal. Emerging from the Gaillard Cut, the ship arrives at the locks on the Pacific side known as Pedro Miguel. Here in a single flight the ship is lowered from the elevation of 85 feet of Gatun Lake, to Miraflores Lake which has an elevation of 54 2/3 feet. After a few miles of navigation through this lake, it reaches the Miraflores locks, where in two flights it is lowered to sea level. From Miraflores locks, it passes through a dredged channel some 8 miles in length, at the end of which it finds itself in deep water.

The Great Slides

The two controlling problems, from the engineering standpoint, in building the Canal were the construction of the Gatun dam, locks and spillway, and the great cutting through the mountains at Culebra. In both cases the task was complicated by the very poor quality of the material in and on which these great works had to be carried out. The ground at Gatun was of a loose and more-or-less swampy character, and the rock is of a late geological formation, which, when exposed to the air and to the heavy rains of the rainy season, rapidly loses its consistency. Fortunately, a fair quality of rock was found at the base of the hills on the easterly side of the site of Gatun dam, and through this the great flight of locks was built. Toward the center of the axis of the dam was another slight hill of rock which was selected for building the spillway. The stability and watertightness of the dam is secured by its enormous width of half a mile and the vast core of impervious clay silt which forms its center.

The cutting at Culebra was the other great obstacle, and here the problem was one of disposal of the spoil or excavated material. The rapidity with which these enormous masses of material were excavated and taken away was due to the use of the very best American excavating machinery, coupled with a skillfully laid out plan of railway trackage. When the United States purchased the Canal from the French company, they found that over 78,000,000 cubic yards had been taken out; but of this only about 30,000,000 was useful to the enlarged American canal. The total excavation, dry and wet, for the Canal as originally planned, was estimated at about 104,000,000 cubic yards, in addition to the French excavation. Additions brought the estimated total to 182,500,000 cubic yards.

The great slides which more than once entirely filled the Canal were due to the fact that whereas the cross section of the Canal, as planned, called for side slopes 1½ to 1, it was found that the rock around Cucaracha, and particularly at Culebra, was of such unstable quality that it was not able to sustain its superincumbent pressure where the depth of the cutting ran into the hundreds of feet. Ultimately it became evident to the engineers that nature must be allowed to have its way and to assume a slope agreeable to the nature of the material. Consequently, a great force of dredges was set to work taking out the material of the slides as it flowed into the Canal. The work was carried on steadily and on a great scale, until at last the slides came to rest at an inclination of 1 to 7.

Engineering and Maintenance

It is gratifying to learn from the last report of the Governor of the Panama Canal that from the standpoint of engineering and maintenance, the Canal is functioning admirably. Of the total rainfall of the Gatun Lake watershed, 12 per cent was absorbed by evaporation, 20 per cent by the hydraulic electric plant at Gatun, 9 per cent by lockages and miscellaneous uses, leaving a margin of 59 per cent which passed over the necessary spillway discharge to maintain the lake at the standard level during the wet season. On December 15, 1918, the elevation of Gatun Lake was 86.98 feet above sea level, and on April 12, 1919, it had been reduced to 83.73 feet. The maximum current velocity, as recorded in the Gaillard Cut section of the Canal was 0.94 knot per hour, which occurred opposite Gold Hill, eight minutes after both chambers of the Pedro Miguel locks had been filled simultaneously.

The number of lockages during the year for all three series of locks was 6,938. Two thousand and sixty-one commercial vessels passed through the Gatun locks, and 282 vessels of the United States Army and Navy for which no tolls were paid. The average time of transit through the Canal was about ten hours.

A new generator unit No. 4 at the Gatun hydraulic-electric section was placed in operation last year bringing the capacity up to 13,500 kilowatts. An additional unit No. 5 has been ordered.

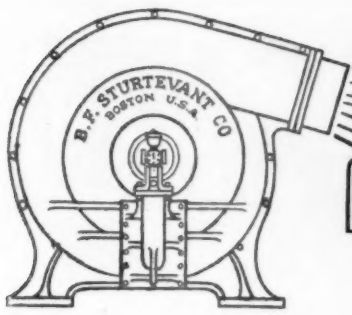
The great Cucaracha slide, from which a total of 5,063,852 cubic yards has been removed by dredges, has been quiescent through the year, and the Culebra slides on the northern side of the Divide have been fairly quiescent. There has been removed from the Culebra slides to date by dredges the vast total of 25,000,000 cubic yards of material. Hydraulic work is being done in sluicing down and reducing the weight of the banks where slides have occurred. On June 30, 1919, 3,454,800 cubic yards remained to be removed from the Canal prism, practically all of it being chargeable to maintenance. At no time during the year was there difficulty in maintaining the full width and depth of the channel in the Culebra slides region.

On June 30, 1919, the total force employed by the Panama Canal and the Panama Railway Company on the Isthmus was 20,361.

The total number of ships making the transit of the Canal during 1919 was 2,025, of which 860 passed from the Atlantic to the Pacific and 1,165 in the contrary direction. The aggregate net tonnage was 6,131,575 tons. The average net tonnage of commercial ships passing through the Canal was 3,337 tons. The ships entering the Canal were classified as follows: United States,786; British, 672; Norwegian, 128; French, 104; Chilean, 83; Japanese, 87; Danish, 79; and the ships of other nationalities in decreasing numbers. The time saved these vessels ran in individual cases as high as 45 days. One vessel from Galveston for Yokohama saved more than $5,000 on the outward voyage alone, as compared with the cost via the Suez route. The tolls collected from vessels using the canal during the year amounted to $6,139,599.

The report of the Governor for 1919 tells us that the ordinary expenses for operation and maintenance of the Canal, including those of civil government and sanitation, amounted to $6,112,195. Offsetting the expenses of operation and maintenance is the amount earned as tolls for vessels passing through the Canal as given above.

(Continued on page 346)



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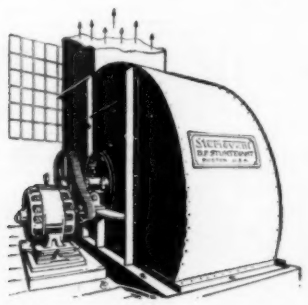
When electricity, steam, and the earth's chemical and physical forces seemed to early man but hostile devils, Nature was employing them as her trained servants. Nature used moving air as conveyor, as dryer or moistener, as purifier, as leveler, as forced draft, as heater or cooler, and as suction cleaner, when man could conceive of no implements other than his teeth and fingers.

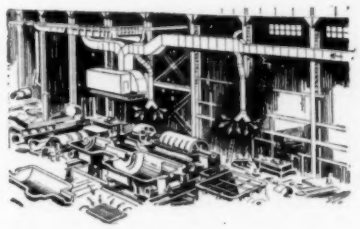
Sturtevant imitates Nature in putting air to work—and the chapter is only at its beginning.

Air brings about a large increase in production

Two buildings of identical construction were devoted to the same kind of work. One building had a



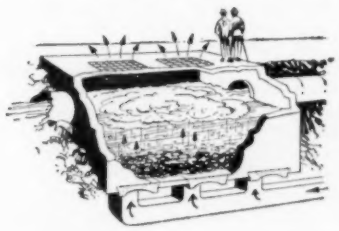
mechanical ventilating system. At the end of the year, production records showed that the employees in the building with the mechanical ventilating system accomplished much more work.



Supplying fresh air to them was a very paying investment.

How Sturtevant Apparatus helped solve a sewage problem

In a Southern city the filthy water of sewers was contaminating the river. The city engineer perfected

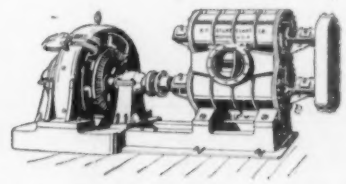


a new system of purifying this sewer water.

He directed the sewage into large cement chambers at the bottom of which were gratings. The air entering through these gratings was forced up through a thick layer of decaying sewage to keep the water in continual activation.

The bacteriological action of this decaying matter hastened the chemical breaking up of the incoming sewage into insoluble gases, a residue that could be shoveled from the bottom of the chambers, and pure water, which flowed into the river. The residue was valuable as a fertilizer.

The air side of this question was left to Sturtevant. A Sturtevant High Pressure Blower was chosen to supply the unchanging volume and constant pressure of air that was so necessary to the success of this system.



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The Panama Canal Today

(Continued from page 344)

The total revenues derived from business operation carried on with Panama Canal funds amounted to $13,684,881, an increase of 32½ per cent over 1918 and 45 per cent over 1917. The cost of carrying on these operations during the last fiscal year amounted to $13,623,854, leaving a net profit of $61,027.

The Romance of Invention—X

(Continued from page 332)

tains only fifty horse-power in his machines; the shafts, bearings, belts, transmission, absorbing the other fifty per cent. If a new and better lubricant can reduce that loss by one-half, what will it mean to the coal piles of this country? For power is nothing but coal: in another form; and one hundred horse-power requires twice as much coal to produce as fifty horse-power.

Dr. Acheson believes that his products are destined to revolutionize lubrication and will provide a saving of natural resources and a conservation of available power in the form of coal and oil, which will be far more important to a world dependent upon power for its very existence than any or all of his numerous other contributions to science and industry.

Dr. Acheson has been held up so many times to the youth of the land as a conspicuous example of how determination and industry can produce success in spite of all obstacles that his romantic story is rather well known. It would be idle to attempt a complete repetition here. Nor would it be anything new to recite a complete list of his achievements. But when a man has produced carborundum, which is now the foundation of huge business; artificial graphite, the making of which is another big business; the process of deflocculation, which has applications to dozens of business, from pottery to lubrication; the commercial manufacture of silicon; the production of siloxican, a highly refractory substance; the manufacture of Egyptianized clay, which must revolutionize the making of pottery; and when he has done all this himself, in spite of discouragements which would stagger a Napoleon, his life can hardly be dismissed with the mere statement "it has been told before."

If you ask Dr. Acheson what his researches and his inventions have taught him about life in general, he is very apt to smile and answer: "Put not your trust in financiers." And then he will explain, with the same smile, that while jewelers recognized the value of carborundum at once, as indeed they had to, it being the only thing of its kind which would cut diamonds, the commercial world refused to see that the manufacture of the artificial abrasive was going to be a great business. Carborundum "went" very slowly and yet its discoverer had the wit to see that it was eventually going to be very "big." So he kept on expanding his plant, and, to do it, kept on giving stock bonuses in order to get the money to expand. The result was the passing of the control of his company from his own hands to others, and the old, old story . . . the inventor and originator frozen out of his own establishment, the fruits of his own labors gathered by other hands.

"Then I borrowed a hundred thousand dollars for graphite," said Dr. Acheson, "and lost twenty thousand dollars of it with the first experiment. That left me eighty thousand dollars. And from that eighty thousand dollars has grown the present Acheson graphite business. And this I control," says Dr. Acheson. "People ask me why, with the new lubricants and the other graphite products, I don't go ahead and advertise largely and build dozens of factories and 'clean up' on it. I answer that I lost one fortune and one great plant by expanding too fast; this one stays in the Acheson family. Anyway, the business is growing of itself as fast as I can keep up with it."

Dr. Acheson's interest in life is in the laboratory. Even in his office in New York he has a little laboratory where he can experiment and where he may show those interested some of the results of his work . . . such as steel with a "graphoid" surface, steel from which the graphite cannot be removed because it has actually entered into combination with the steel, producing a smoothness and a frictionless surface which means much when that surface is in a bearing. Here, too, you shall see, if Dr. Acheson has time and you his ear, how black graphite can pass through the finest of filter paper. Here you shall be convinced, by demonstration beneath the ultramicroscope, of the similarity between what is called the colloids of lubricating oil and the colloidal particles which are deflocculated graphite. Here you shall hear the wonder story of lubrication and marvel anew that the key to anything so practical and hard-headed and mechanical as an easy-running bearing with small power loss, was tied up with pottery and clay and the Biblical story of captives in ancient Egypt.

Dr. Acheson looked oddly when his visitor asked, in all innocence, "Do you regard carborundum as your greatest achievement?" He made no answer, then, but went on to demonstrate what artificial graphite might be, how it was produced in the electric furnace, and what deflocculation was and how produced. Afterwards, he turned to the writer and said, "Do you still think you need ask if carborundum is the most important thing I have done?"

It seems odd that the man who first produced the greatest agent of artificial friction—carborundum, which now grinds the tools of the world—should have devoted the rest of his life to the exact opposite: finding that substance which would best grease the wheels of industry. It is more remarkable when it is understood that artificial graphite is a further result of electric furnace work, the same electric furnace which takes coke and sand and makes of them the hardest substance known.

Let no one think that artificial or synthetic graphite is only a lubricant; it can be used in a thousand ways for a thousand things. It is only when it is deflocculated and applied in a carrier—oil or grease or water—that it becomes so important in the lubricating field. The synthetic graphite industry was a large one before deflocculation was thought of, yet, in its parent's opinion, the most recent child is to outstrip them all in importance and in magnitude.

Dr. Acheson is father of some fifty patents. Among them is a method of making ink from deflocculated carbon-black which produces some astonishing results in the printing of half-tone plates and in lithography. He is now developing a new filtration apparatus for household use, based again on the principle of deflocculation, which provides a filtering medium through which germs cannot pass—a thing, by the way, which has not hitherto been accomplished.

His honors have left him untouched. They have been many, but his head is too sensible for turning. A real sense of humor and what must be called, for want of a better name, an appreciation of the common sense of the art of living, make the outward and visible Dr. Acheson a transparent indicator of the real character of the inward and hidden Dr. Acheson. Kindly, human, charitable, interested as much in men and human relations as in science and scientific process, a man of many friends and a few good healthy enemies without whom no one can be considered successful, Dr. Acheson can point to successful results in many experiments in humanity as well as many in the laboratory.

Dr. Acheson is not through. It is doubtful if he will ever be through ex-

(Continued on page 348)

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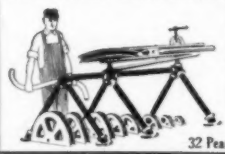
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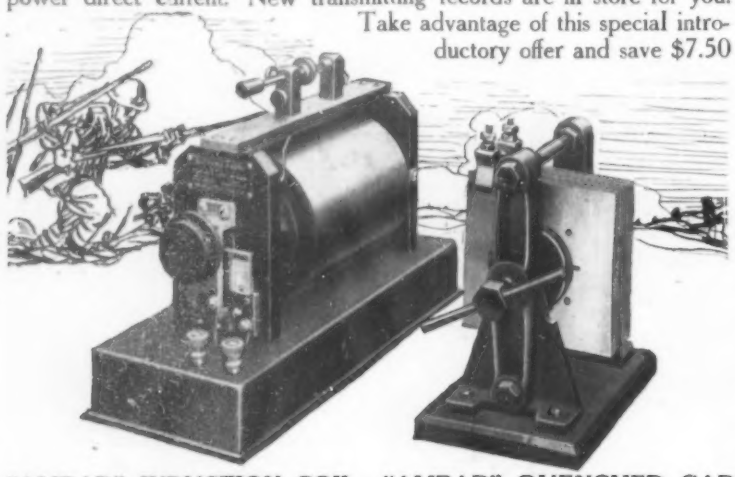

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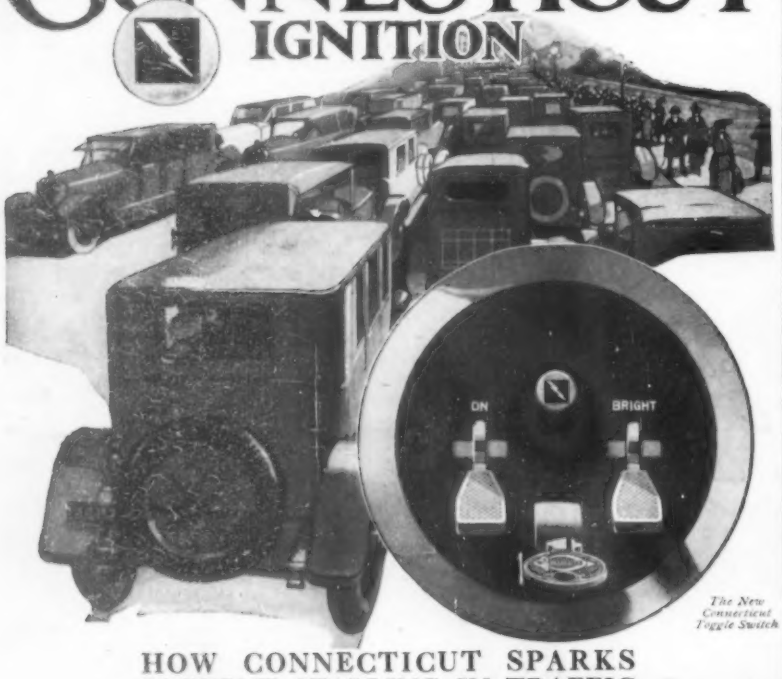

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CONNECTICUT TELEPHONE & ELECTRIC COMPANY
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The Romance of Invention—X

(Continued from page 346)

perimenting, testing, contriving, inventing, improving, remaking. But at the present it seems as if, of all the many real contributions he has made to the worlds of science and industry, none will give him greater fame or humanity more benefit than the discovery, concealed in the verse in Exodus, of a means of more finely dividing matter than physical science has ever before possessed—this same principle of deflocculation which has opened up so many new fields to so many industries, as well as giving a new tool to the laboratory and a new meaning to the word lubrication.

Testing Airplane Propellers

(Continued from page 333)

for all the general tests) is reached. This speed doubtless corresponds to the critical speed for the aerofoil at the extreme tip; and when we go above it, we attain progressively the critical speeds of sections nearer the hub, so that the efficiency of the entire propeller is considerably lowered—and with it, the thrust-torque ratio.

Another theoretical conclusion that has to be revised a bit in the light of the propeller tests is the one that would have the horse-power proportioned to the cube of the angular velocity. From 700 to about 1,500 revolutions per minute the horse-power is somewhat lower than it would be under the assumption of actual proportionality with the cube of the velocity; above that, it is a trifle in excess, with the discrepancy an increasing one.

The change in angle of the propeller while in motion offers some very valuable data to the designer. While the distortion at a fixed point undoubtedly differs considerably from that encountered in flight, experiments on a series of blade-shapes have made it possible to draw some important conclusions as to the effect of different blade-shapes on the distortion. The results here have been particularly useful in connection with the stress analysis of propellers.

The actual destructive tests—the applying of force after force to a member until it fails, which is what the layman usually visualizes when we say "test" to him—have covered a wide field. At least two inventions, the bakelite propeller and the variable-pitch propeller, have been developed, without leaving the ground, to a point where they bid fair to become important factors in the aeronautical industry. The *modus operandi* of these tests we have tried to make as clear as possible in this unillustrated article, which is all that limitations of space permit us to give it; for a fuller discussion, freely illustrated with photographs and diagrams, the reader is referred to the current SCIENTIFIC AMERICAN MONTHLY, for March, 1920.

Why the Trailer Has Made Good

(Continued from page 334)

This, however, does not by any means indicate that trailers cannot be used where conditions are bad. For heavy work the truck manufacturers, working independently or hand-in-hand with the trailer people, have developed the tractor, which is simply a short-wheelbase truck of very substantial construction and with sufficient power to handle heavy trailers or semi-trailers over any roads that can be traveled. The tractor usually carries no load except the front end of the trailer, in the case of a semi-trailer outfit.

Just here it may be well to point out that the trailer does not encroach upon the field of the motor truck manufacturer or dealer. True, it makes for economy in the use of trucks, as well as in other ways reducing haulage expense; but, on the other hand, it makes possible the use of motor trucks where they could not otherwise be employed with profit. In hauling low-priced commodities it might

(Continued on page 350)

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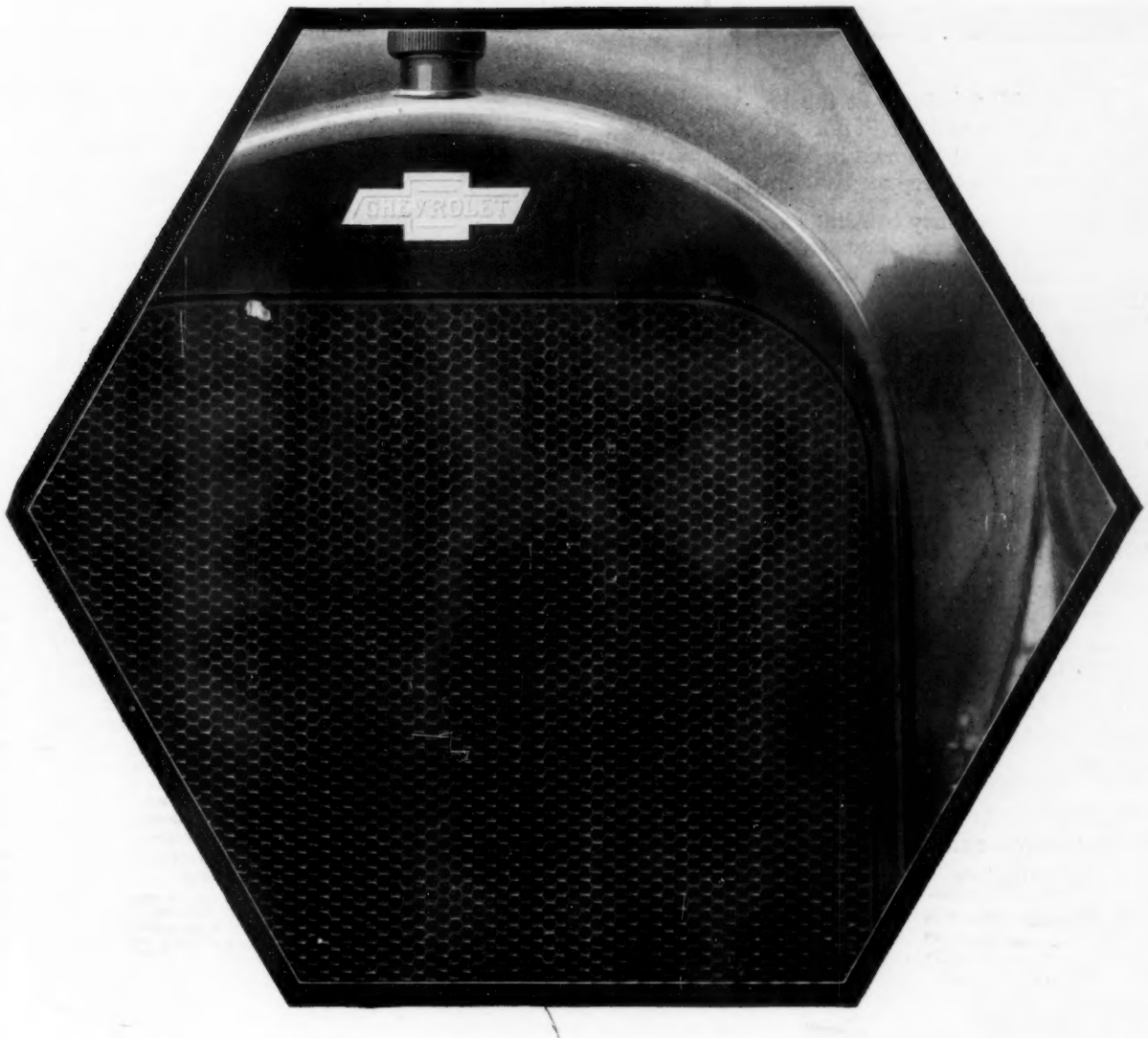

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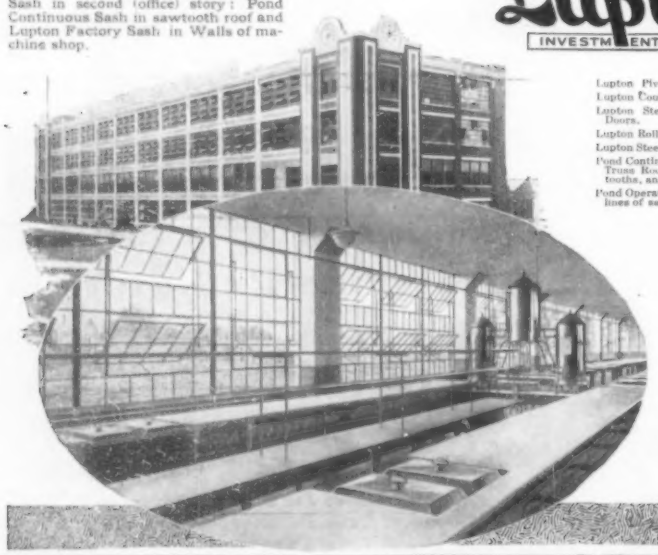

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Why the Trailer Has Made Good

(*Continued from page 348*)

not be profitable to handle only the quantity that could be loaded in a truck and two trucks would, of course, double—or almost double—the operating expense. A trailer, however, carrying a load equal to the truck, would add but twenty per cent or so to the hauling cost and make the work pay. Again; it might be desirable to haul a large quantity in a single load, to save space. In this case the semi-trailer, which is built in capacities up to ten tons and even more, answers admirably, for it occupies but little more space than a large truck of half that capacity and obviously costs far less than two five-ton trucks, both as to first price and as to operation and maintenance. There is also a distinct gain, in some classes of work, in the fact that a trailer can be left for loading and unloading while the truck or tractor keeps busy handling other trailers, so that the loss due to idle time is minimized.

A feature of the trailer principle that has an appeal to a very large class of users is that it offers what is probably the most inexpensive and convenient way of taking care of extra loads which are not of sufficiently frequent occurrence to warrant the purchase of an extra motor truck. For instance, one or two three-ton trucks may be in regular use, working well up to capacity and keeping busy. Under these conditions an extra load or two would necessitate an extra trip, the hiring of another truck, or some equally undesirable expedient. That is, if no trailer were available. With a trailer, however, the load could be put on and the vehicle coupled to one of the trucks and the extra load or loads hauled on regular trips at a very slight extra cost.

There are also cases where a division of the load is desirable from other points of view. Where the roads are soft, for instance, a truck with a six-ton load might cut up the surface badly, while a three-ton truck hauling a three-ton trailer would distribute the weight over such a large tire area that there would be no more than normal wear and tear on the road surface.

Again, a trailer is a valuable time-saver in cases where part of the total loading is to be delivered at one place and the rest at another. Under such conditions the truck or tractor will lose no more time than that required for uncoupling and coupling up again.

The upkeep cost of a trailer is low because of its simplicity, the small number and the substantial construction of the working parts and the fact that it is drawn and does not suffer from the wear and tear incident to the developing and application of tractive force. This last consideration is an important one, for it affects the tire question. Trailers are equipped with solid rubber tires of the same sizes, generally speaking, as those used on motor trucks of similar load-carrying capacity. As the tires are required to transmit no power, however, they last much longer than the truck or tractor tires. Just how much longer it is not possible to say, for circumstances and conditions of operation enter largely into the problem. It is not uncommon, however, to get 50 per cent longer life, and in some cases increases up to 80 per cent and even more have been obtained.

The moving parts subject to wear are those which, in the motor truck, are causes of the least trouble—wheel bearings, steering gear, and springs. There is also the coupling device; this, with the good construction and materials commonly used, is practically a nonentity as a trouble-maker. The life of a trailer as a whole is considerably longer than that of a motor truck. The period of usefulness of the power vehicle is, to all intents and purposes, limited to the life of the power plant and transmission mechanism. When these are gone beyond redemption the rest of the truck often is in fair condition. So the trailer, with the same substantial construction as the truck but relieved of the severe service imposed by the development transmission and application of power, may reasonably be expected to be still in good working order when the truck has become worn out.

Braking has not proved a serious problem in trailer work. Under all ordinary conditions the truck brakes are ample to handle all the load without undue deterioration. For unusual conditions the trailers are in many instances supplied with their own brakes which are operated by the truck driver. Air brakes have been applied with success, and these have the advantage that should the trailer break loose—which is a rare occurrence—it will stop itself, just as a railroad car stops itself if it breaks loose from the train.

The shocks and jars of starting and stopping a trailer load are taken care of, as a rule, by the spring suspension, in some cases aided by the use of a spring drawbar. The suspension springs are required only to carry the load and transmit to the axles and wheels a force that is very moderate as compared with the force the rear springs of a truck are called upon to withstand. So they can be shackled at both ends, forming a kind of floating connection that gives flexibility in starting and stopping.

Four-wheeled trailers are made both single-ended and double-ended—that is, they can be hauled either end first. Steering is through knuckles of the truck type, and the steering connections are so worked out that the trailer follows accurately. Both two-wheel steer and four-wheel steer are provided in some trailers of the four-wheel types. Steering is commonly effected through a connection between the drawbar, which swings laterally, and the steering knuckles.

Trailers provide a means for handling some loads that could not otherwise be handled. For instance, long poles or logs that could not be loaded on a truck because of the excessive length, are readily hauled by supporting the extending end on a two-wheeled trailer or "dolly." This permits the distribution of the load in any proportions required. The transportation of very heavy loads over level roads for short distances has already been mentioned. The trailer is also useful where the load is exceedingly bulky, though not heavy, for it gives an opportunity to extend the load lengthwise as much as may be necessary, avoiding excessive width and height.

One-Man Trolley That Runs on Short Headway

(*Continued from page 335*)

the long run there are less stops. Under the old system, trolley riders must have noted that when a car running on 15-minute headway falls behind its schedule by five or ten minutes, the car behind it loses traffic; the late car gets passengers who would ordinarily be on the following car, and the latter has fewer stops to make. The same thing applies to a shorter regular headway; if cars pass every ten minutes in place of every fifteen, there will be many stations at which the interval of fifteen minutes would have brought forth a passenger, but at which the ten-minute lapse between cars will not do so. Result—a stop saved; time saved for the passengers and the power-loss and wear-and-tear incident to a stop saved the company. Then, too, with "a car always in sight"—the slogan of the one-man-car builder—many short-haul passengers who would ordinarily walk will be tempted to ride.

The faster operation of these cars is fully protected by their equipment of safety devices, which are all automatic. As in the New York subways, the operator must hold the controller down against a light spring in order to keep the car

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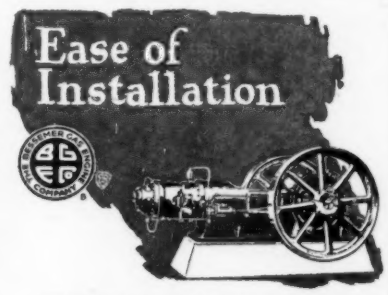

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running; if he becomes incapacitated or withdraws his attention from the business in hand, the withdrawal of his pressure from the controller handle will at once shut the doors, apply the brakes, cut out the motor, sand the track, and release the doors from electric control so that they may be opened by hand for the escape of the passengers. The operation of doors and step is interlocked with the air-brake handle in such fashion that the car, when standing, cannot start until the doors are closed; while if the car is running, the thing works the other way and the doors cannot be opened nor the step lowered until the car comes to a full stop.—By *Ralph Howard.*

The Latest Word in Steel

(Continued from page 336)

cent and the average is .3 to .4 per cent. English steel tool makers have perfected a molybdenum steel combined with cobalt in which the molybdenum content runs as high as nearly 6 per cent; this product is utilized for tools which are subjected to excessive heat caused by friction in cutting.

With its steel-hardening quality, molybdenum steel combines lightness and strength; lends itself to easier machining with a much wider range of heat treatment; possesses a greater tensile strength and a greater elongation with a higher dynamic impact value.

This latter quality—that of greater dynamic and impact value which mean superior resistance to repeated stresses and suddenly applied shocks—should make of molybdenum steel a much more satisfactory medium for making springs than the former standard chrome-vanadium steel springs. In substantiation of this claim, it is pointed out that the Fifth Avenue busses in New York City employ springs of molybdenum steel.

Corresponding somewhat to the English formula for tool steels, in that the content of molybdenum is greater than in the American automotive steel, the German formula has become known in this country. The Germans made use of molybdenum when their supply of tungsten ran out. It is believed that they learned of its value from observers who told them of English utilization of it. Most of the German supply came from Norway.

As evidence of the increased use of molybdenhm, it has been estimated that, in the last two years, 100,000 tons of molybdenum steel have been manufactured in the United States alone. Primarily a toughener of steel, molybdenum acts more beneficially upon steel than chromium because it does not develop the quality of brittleness that is characteristic of simple chromium steel. By the addition of molybdenum, brittleness decreases and toughness increases.

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Both the transparent front and the coated fabric back are water-proof and grease-proof. Dirt or grease may easily be wiped or washed off either without injury to the material. Both materials are flexible and the holder may be rolled up if desired in the same way an unprotected blue-print is usually handled by a workman.

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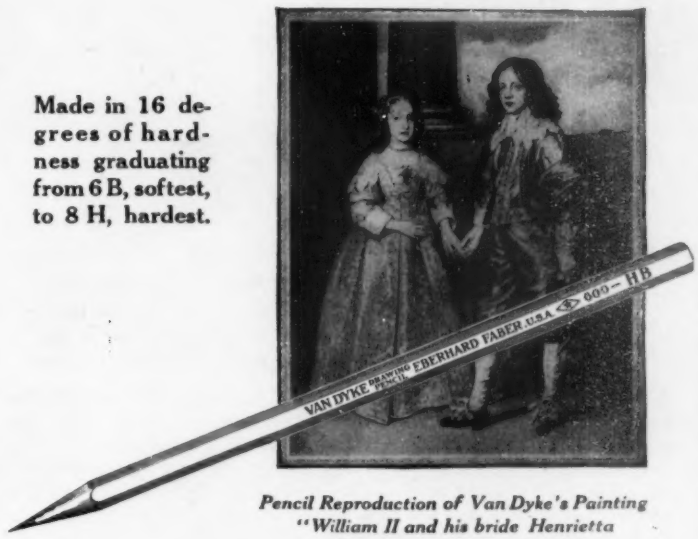

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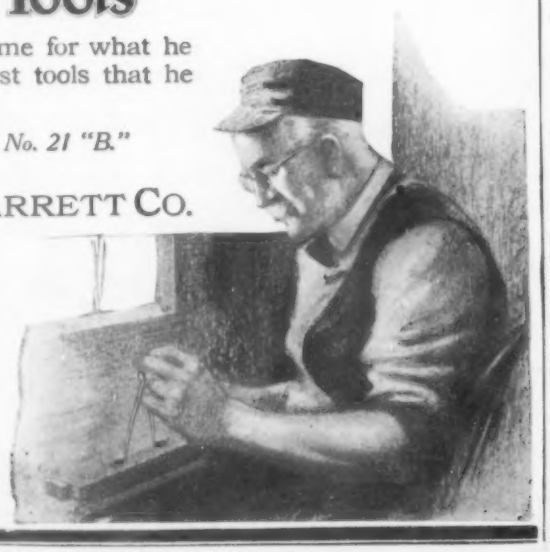

How Colloidal Chemistry Aids the Paving Industry

(*Continued from page 337*)

of subdivision intermediate between the molecular condition and that in which they ordinarily exist, a condition so fine that the particles will pass the finest filters, even those of biscuit porcelain. It at once occurred to Mr. Richardson that a portion or perhaps all of the clay in Trinidad asphalt was in this condition.

Trinidad asphalt as taken in its crude state from the deposit on the Island of Trinidad, B. W. I., contains an unvarying 27 per cent of mineral matter. Under the ultra-microscope it has now been shown that this matter consists largely of material in a colloidal state—colloidal clay. These colloidal particles are of a size as small or smaller than .0001 mm., a micron. The extreme fineness of this colloidal clay is demonstrated in a very practical fashion by the fact that it does not settle in solutions of the bitumen which have been standing for years, and that under the ultra-microscope it is shown to be in that active state of motion called the Brownian movement, which is characteristic of all highly dispersed colloidal material.

Although the cinematograph is always with us, we do not often think of it as a means of exhibiting sub-microscopic movement. This, however, has actually been accomplished, and at a recent meeting of the New York Section of the American Electro-chemical Society there was shown a moving picture clearly depicting the Brownian oscillations of colloidal clay in a solution of Trinidad asphalt. This picture was made by joining the lens of a cinematograph camera to the eye-piece of an ultra-microscope focussed upon the colloidal solution. A picture of the same solution taken through an ordinary microscope without illumination disclosed no visible particles nor any movement.

The "body" or stability of the bitumen of Trinidad asphalt can now be accounted for; but more important than this is the fact that the whole theory of a sheet asphalt pavement is now put on a rational basis.

What is sought in the formulation of asphalt paving mixtures is to provide a maximum of surface area to which the bituminous cement may adhere. A pound of dust such as is ordinarily used in such mixtures contains 192,715,000,000 particles, having a surface area of 528,000 square feet. In order to realize how enormously the surface area is increased when colloidal matter is introduced, it is only necessary to consider that if an amount of material represented by a cube 1 centimeter in diameter is reduced to only the coarsest colloidal size (one ten-thousandth of a millimeter in dimension) the surface area of the original cube will be increased to 60 square meters, or 100,000 times more than that of the original cube.

Electricity's Latest Contribution to the Modern Art of Heat Treatment

(*Continued from page 337*)

of units are connected in series, depending upon the voltage of the power supply.

The construction of the vertical-cylindrical high temperatures heat-treating furnaces involves the use of a heavy resistance ribbon supported on the inner walls of the furnace. The furnace is divided into a number of separate heating zones with an automatic temperature control for each. The walls consist of an inner lining of refractory brick and insulators backed up by a double course of heat-insulating brick and protected by a sheet metal casing. The ribbon supports and insulators are both of molded special compound laid in the lining of refractory brick with a spacing block of the same material placed between the insulators of adjacent windings, or zones. The insulators, spacers, and spacing blocks are fitted at the back into a steel channel *H* which is in the form of a ring made up of a number of sectors tied together by bolted clamps, not shown in the accompanying view. The spacing block *A* acts as a protecting buffer for the ribbon support insulators and any blow is transmitted to and distributed by the channel *H*. An opening is provided in the spacing block *A* for the charge pyrometer tube, with a similar opening for the ribbon pyrometer in the support insulator at *D*. The ribbon is welded to the terminal stud *E* and adjacent lengths of ribbon are joined by welding to the splice piece *J*.

The Heavens in April, 1920

(*Continued from page 338*)

recession—168 kilometers per second. This may well represent the motion of the cloud as a whole, but further evidence is desirable.

Finally the volume is concluded by an important paper by Professor W. H. Wright upon the spectra of the gaseous nebulae. Of his conclusions, we may mention (1) the discovery of lines of carbon (or some carbon compound) and of nitrogen in the spectra of the nebulae; (2) the discovery that the nuclei, or "central stars," of many planetary nebulae show the typical spectrum of the so-called Wolf-Rayet stars, and that there is an intimate connection between the nebulae and these stars; and (3) that these nuclei give out a relatively very large amount of ultra-violet light, and are probably exceedingly hot bodies.

The Heavens

Our map shows the appearance of the constellations so well that little description is necessary. Gemini and Canis Minor are in the west. Leo is higher up, with Virgo to the left, and Hydra below both. Bootes, Corona and Hercules are conspicuous in the east, and Lyra is low in the northeast. The Great Bear is high overhead, the Little Bear and the dragon are below, and Cassiopeia still lower, on the northern horizon. Auriga, in the northwest, is the last remaining conspicuous constellation. Jupiter, Saturn and Mars are all well visible, and add to the brilliancy of the sky.

The Planets

Mercury is a morning star all this month, and reaches elongation on the 17th, when he is 27 degrees west of the sun. At the time he rises at 4:30 A. M., and is conspicuous in the dawn.

Venus too is a morning star, and is in conjunction with Mercury on the 4th, when the two planets are little more than a degree apart. After this date she appears closer to the sun than Mercury, but being brighter will be at least as easy to see.

Mars is in opposition on the 21st, and is visible all night long. He is in the eastern part of Virgo, and is a very conspicuous object, almost as bright as Sirius, and far exceeding any other star. Jupiter is in Cancer and remains visible until long after midnight. Saturn is in Leo and crosses the meridian at 9 P. M. in the middle of the month, setting an hour and a half later than Jupiter.

Uranus is in Aquarius, and rises about three hours before the sun. Neptune is in Cancer, and observable all the evening. On the 19th he is 55′ north of Jupiter—a good chance to pick him up with a small telescope.

The moon is full at 6 A. M. on the 3rd, in her last quarter at 8 A. M. on the 11th, new at 5 P. M. on the 18th, and in her first quarter at 8 A. M. on the 25th. She is nearest the earth on the 20th, and farthest away on the 8th. She passes near Mars on the 5th, Uranus on the 13th, Mercury on the 16th, Venus on the 17th, Neptune and Jupiter on the 25th, and Saturn on the 27th—none of these conjunctions, however, being close.

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